

Agilent 4294A Precision Impedance Analyzer

Service Manual

Third Edition



Agilent Technologies

Manufacturing No. 04294-90110

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Manual Printing History

The manual's printing date and part number indicate its current edition. The printing date changes when a new edition is printed. (Minor corrections and updates that are incorporated at reprint do not cause the date to change.) The manual part number changes when extensive technical changes are incorporated.

October 1999	First Edition
June 2000	Second Edition
January 2007	Third Edition

Safety Summary

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific WARNINGS elsewhere in this manual may impair the protection provided by the equipment. In addition it violates safety standards of design, manufacture, and intended use of the instrument.

The Agilent Technologies Company assumes no liability for the customer's failure to comply with these requirements.

NOTE

4294A comply with INSTALLATION CATEGORY II and POLLUTION DEGREE 2 in IEC61010-1. 4294A are INDOOR USE product.

NOTE

LEDs in 4294A are Class 1 in accordance with IEC60825-1.
CLASS 1 LED PRODUCT

- Ground The Instrument

To avoid electric shock hazard, the instrument chassis and cabinet must be connected to a safety earth ground by the supplied power cable with earth blade.

- DO NOT Operate In An Explosive Atmosphere

Do not operate the instrument in the presence of flammable gasses or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

- Keep Away From Live Circuits

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with the power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

- DO NOT Service Or Adjust Alone

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

- DO NOT Substitute Parts Or Modify Instrument

Because of the danger of introducing additional hazards, do not install substitute parts or perform unauthorized modifications to the instrument. Return the instrument to a Agilent Technologies Sales and Service Office for service and repair to ensure that safety features are maintained.

- Dangerous Procedure Warnings

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

Dangerous voltages, capable of causing death, are presenting this instrument. Use extreme caution when handling, testing, and adjusting this instrument.

Safety Symbol

General definitions of safety symbols used on the instrument or in manuals are listed below.



Instruction Manual symbol: the product is marked with this symbol when it is necessary for the user to refer to the instrument manual.



Alternating current.



Direct current.



On (Supply).



Off (Supply).



In position of push-button switch.



Out position of push-button switch.



Frame (or chassis) terminal. A connection to the frame (chassis) of the equipment which normally include all exposed metal structure.

WARNING

This warning sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personnel.

CAUTION

This Caution sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

NOTE

Note denotes important information. It calls attention to a procedure, practice, condition or the like, which is essential to highlight.

Certification

Agilent Technologies Company certifies that this product met its published specifications at the time of shipment from the factory. Agilent Technologies further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, to the extent allowed by the Institution's calibration facility, or to the calibration facilities of other International Standards Organization members.

Warranty

This Agilent Technologies instrument product is warranted against defects in material and workmanship for a period corresponding to the individual warranty periods of its component products. Instruments are warranted for a period of one year. Fixtures and adapters are warranted for a period of 90 days. During the warranty period, Agilent Technologies Company will, at its option, either repair or replace products that prove to be defective.

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Agilent Technologies warrants that its software and firmware designated by Agilent Technologies for use with an instrument will execute its programming instruction when properly installed on that instrument. Agilent Technologies does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

Limitation of Warranty

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside the environmental specifications for the product, or improper site preparation or maintenance.

IMPORTANT

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The remedies provided herein are buyer's sole and exclusive remedies. Agilent Technologies shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.

Assistance

Product maintenance agreements and other customer assistance agreements are available for Agilent Technologies products.

For any assistance, contact your nearest Agilent Technologies Sales and Service Office. Addresses are provided at the back of this manual.

Typeface Conventions

Bold	Boldface type is used when a term is defined. For example: icons are symbols.
<i>Italic</i>	Italic type is used for emphasis and for titles of manuals and other publications.
[Hardkey]	Indicates a hardkey labeled “Hardkey.”
Softkey	Indicates a softkey labeled “Softkey.”
[Hardkey] - Softkey1 - Softkey2	Indicates keystrokes [Hardkey] - Softkey1 - Softkey2 .

4294A Documentation Map

The following manuals are available for the 4294A.

- **Operation Manual (Agilent P/N: 04294-900x0)**
Most of basic information necessary for using 4294A is described in this manual. It includes the way of installation, preparation, measurement operation including calibration, performances (specifications), key definitions, and error messages. For GPIB programming, see the *Programming Manual* together with “*HP Instrument BASIC User's Handbook*”.
- **Programming Manual (Agilent P/N: 04294-900x1)**
The Programming Manual shows how to write and use BASIC program to control the 4294A and describes how HP Instrument BASIC works with the analyzer.
- **HP Instrument BASIC User's Handbook (Agilent P/N: E2083-90005)**
The *HP Instrument BASIC User's Handbook* introduces you to the HP Instrument BASIC programming language, provide some helpful hints on getting the most use from it, and provide a general programming reference. It is divided into three books, *HP Instrument BASIC Programming Techniques*, *HP Instrument BASIC Interface Techniques*, and *HP Instrument BASIC Language Reference*.
- **Service Manual (Agilent P/N: 04294-901x0, Option 0BW only)**
This manual describes how to adjust and repair the 4294A, and how to carry out performance tests. This manual will be attached if you take the Option 0BW.

NOTE

The number position shown by “x” in the part numbers above indicates the edition number.

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1 General Information

This *Service Manual* is a guide to servicing the 4294A Precision Impedance Analyzer. The *Service Manual* provides information about performance testing, adjusting, troubleshooting, and repairing the 4294A.

Organization of Service Manual

This manual consists of the major chapters listed below. This section describes the names of the chapters and the content of each chapter.

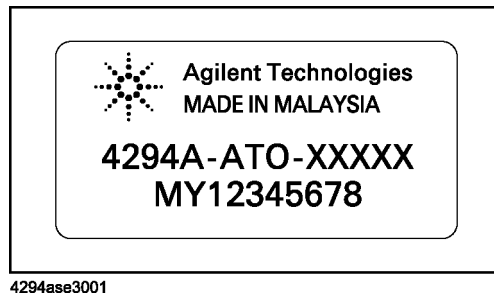
- *Performance Test* provides procedures for performance testing the 4294A.
- *Adjustment* provides procedures for adjusting the 4294A after repair or replacement of an assembly. Most of the adjustments update the correction constants stored into the EEPROM on the A1 CPU. The correction constants are updated by using the adjustment program.
- *Troubleshooting* provides troubleshooting procedures to isolate any faulty functional group or faulty assembly. Faulty assembly isolation procedures for the faulty functional group follow this chapter.
- *Power Supply Troubleshooting* provides troubleshooting procedures to isolate any faulty assembly within the power supply functional group.
- *Digital Control Troubleshooting* provides troubleshooting procedures to isolate any faulty assembly within the digital control functional group.
- *Service Related Menus* documents the functions of the menus accessed from **[System]**, **DIAGNOSTIC TEST**. These menus are used to test, verify, and troubleshoot the 4294A.
- *Theory of Operation* explains the overall operation of the 4294A, the division into functional groups, and the operation of each functional group.
- *Parts Replacement* provides part numbers and illustrations of the replaceable assemblies and miscellaneous chassis parts. This chapter also provides procedures to disassemble portions of the analyzer when certain assemblies have to be replaced.
- *Post Repair Procedures* contains the table of related service procedures. It is a table of adjustments and verification procedures to be performed after repair or replacement of each assembly.
- *Appendices* contains manual change information (required to make this manual compatible with earlier shipment configurations of the analyzer), power requirements and error messages of the analyzer.

Instruments Covered by This Manual

Agilent Technologies uses a two-part, ten-character serial number label (See Figure 1-1) attached to the instrument's rear panel. The first five characters are the serial prefix and the last five digits are the suffix.

Figure 1-1

Serial Number Label



An instrument manufactured after the printing date of this manual may have serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates the instrument is different from those described in this manual. The manual for this new instrument may be accompanied by a yellow *Manual Changes* supplement or have a different manual part number. This sheet contains “change information” that explains how to adapt the manual to the newer instrument.

In addition to change information, the supplement may contain information for correcting errors (Errata) in the manual. To keep this manual as current and accurate as possible, Agilent Technologies recommends that you periodically request the latest *Manual Changes* supplement. The supplement for this manual is identified by this manual's printing data and is available from Agilent Technologies. If the serial prefix or number of an instrument is lower than that on the title page of this manual, see *Appendix A, Manual Changes*. For information concerning, a serial number prefix that is not listed on the title page or in the *Manual Changes* supplement, contact the nearest Agilent Technologies office.

Require Equipment

Table 1-1 lists the recommended equipment for performing maintenance on the 4294A.

Table 1-1 Recommended Test Equipment

Equipment	Critical Specifications	Recommended Model	Qty.	Use ^{*1}
Frequency Counter	Frequency Range: 10 MHz, Time Base Error: $\leq \pm 1.9 \times 10^{-7}$ /year	5334B, or 53181A	1	P,A
Frequency Standard	Frequency: 10 MHz, Time Base Error: $\leq \pm 1 \times 10^{-10}$ /year	5061B, or 5071A	1	P,A
Multimeter	No Substitute	3458A	1	P,A
Power Meter	No Substitute	437B, 438A, E4418A/B, or E4419A/B	1	P,A
Power Sensor	Frequency Range: 1 MHz to 110 MHz Power: -30 dBm to 20 dBm	8482A	1	P,A
Standard Capacitor	No substitute	16380A	1	P,A
Standard Capacitor	No substitute	16380C	1	P
Standard Resistor	No substitute	42030A	1	P
4TP OPEN termination	No substitute	42090A	1	P,A
4TP SHORT termination	No substitute	42091A	1	P,A
Performance Test Kit	No substitute	16190A	1	P
7mm Terminal Adapter	No substitute	42942A	1	P
Test Leads 1m	No substitute	16048G ^{*2}	1	P
Test Leads 2m	No substitute	16048H ^{*2}	1	P
100 Ω Resistor	No substitute	p/n 04294-61001 ^{*3}	1	P,A
4TP to BNC Interface Box	No substitute	p/n 04294-61002	1	P,A
Two-Way Power Splitter	Frequency Range 1 MHz to 110 MHz, Output Tracking ≤ 0.15 dB	11667A	1	P,A
Cables	BNC(m)-BNC(m) Cable, 61 cm	p/n 8120-1839	1	P,A
	Banana(m)-Banana(m) Cable	11058A	2	A

Table 1-1 Recommended Test Equipment

Equipment	Critical Specifications	Recommended Model	Qty.	Use ^{*1}
Adapter	7 mm-N(m) Adapter	11525A	1	P
	Dual Banana-BNC(f) Adapter	p/n 1251-2277	1	P,A
	N(m)-BNC(m) Adapter	p/n 1250-0077	1	P,A
	BNC(f)-BNC(f) Adapter	p/n 1250-1830	4	A
	BNC(m)-Banana(m) Adapter	p/n 1250-1263	4	A
Termination	50 Ω termination	909C Opt.012	1	P,A

*1. P:Performance Test A:Adjustment

*2. 16048A/D cannot be used for a substitute.

*3. furnished with the 4294A

2 Performance Test

This chapter contains the performance test for the 4294A Precision Impedance Analyzer. These performance tests are used to verify that the analyzer's performance meets its specifications.

Performance Test

Introduction

This section provides the test procedures used to verify that the 4294A's specifications are met. The performance tests can also be used for incoming inspection, and for verification after troubleshooting or adjustment. If the performance tests indicate that the 4294A is *NOT* operating within the specified limits, check your test setup, then proceed with troubleshooting if necessary.

Warm Up Time

Allow the 4294A to warm up for at least 30 minutes before you execute any of the performance tests

Ambient Conditions

Perform all performance tests in ambient conditions of $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, $\leq 70\%$ RH.

Performance Test Interval

The performance test should be performed periodically. The recommended test interval is 12 months.

NOTE

The test interval depends on maintenance of use and the environmental conditions under which the instrument is used. You may find that the test interval could be shortened or lengthened; however, such a decision should be based on substantial quantitative data.

Performance Test Record and Calculation Sheet

Performance test record lists all test points, acceptable test limits, test result entry columns, and measurement uncertainties. The listed measurement uncertainties are valid only when the recommended test equipment is used.

The calculation sheet is used as an aid for recording raw measurement data, and for calculating the performance test results.

The procedure for using the calculation sheet and performance test record is;

1. Photo copy the calculation sheet.
2. Follow the performance test procedure and record the measurement values, the 4294A's reading, etc., into the specified column on the calculation sheet.
3. Calculate the test result using the appropriate equation given on the calculation sheet, and record the test result into the Test Result column of the performance test record.

Test Equipment

Table 1-1 lists the recommended equipment for performing maintenance on the 4294A.

Frequency Accuracy Test

This test checks the frequency accuracy of the internal frequency reference with a frequency counter and a frequency standard.

Specification

Frequency Accuracy: ± 20 ppm at (23 ± 5) °C (without Option 1D5)
 ± 0.13 ppm at 0 °C to 55 °C (with Option 1D5)

Test Equipment

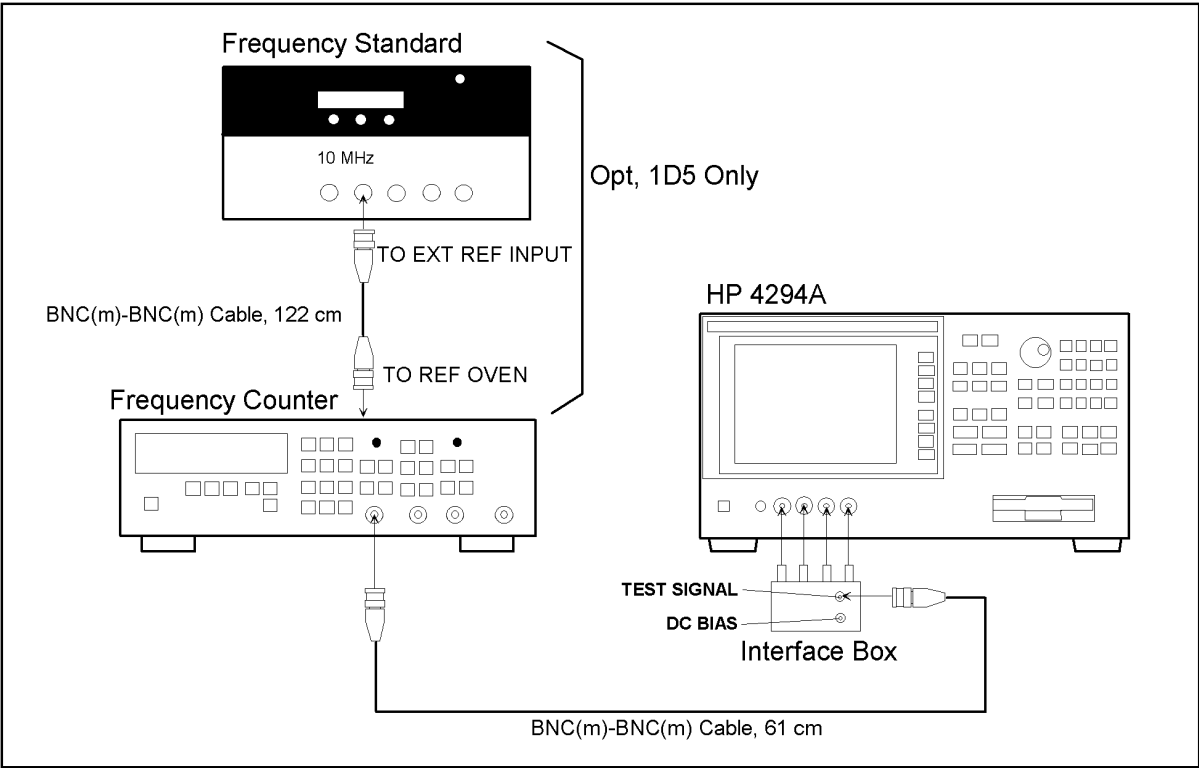
Description	Recommended Model
Frequency Counter	5334B or 53181A
Frequency Standard	5071A
4TP to BNC Interface Box	p/n 04294-61002
BNC(m) -BNC(m) Cable, 61 cm	p/n 8120-1839
BNC(m)-BNC(m) Cable, 122 cm	p/n 8120-1840

Procedure

1. Connect the test equipment as shown in Figure 2-1. For testing the 4294A with Option 1D5, connect a BNC(m)-BNC(m) cable between the EXT REF Input connector and the REF OVEN connector on the analyzer rear panel.

NOTE If testing the 4294A without Option 1D5, the frequency standard is not required.

Figure 2-1 Frequency Accuracy Test Setup



4294ase02001

2. Initialize the frequency counter. Then set the controls as follows.

Gate Time: 1 sec.

INT/EXT Switch (rear panel, 5334B only) EXT*1

*1. If the frequency standard is not connected, set the switch to INT.

3. Press **[Preset]** to initialize the 4294A. Then set the controls as follows.

Setting	Operation
Frequency Span: 0 Hz	[Span] - [0] - [×1]
Center Frequency: 10 MHz	[Center] - [1] - [0] - [M/m]
OSC Level: 0.25 V	[Source] - LEVEL - [.] - [2] - [5] - [×1]
Number of Points: 2	[Sweep] - NUMBER OF POINTS - [2] - [×1]
Trigger Mode: Single	[Trigger] - Single

4. Subtract 10 MHz (analyzer setting) from the frequency counter reading, and record the result on the performance test record.

OSC Level Accuracy Test

This test checks the actual power level of the test signal at 10 MHz.

Specification

OSC Level Accuracy: $\pm[(10 + 0.05 \times f[\text{MHz}]) \% + 1\text{mV}]$

Test Equipment

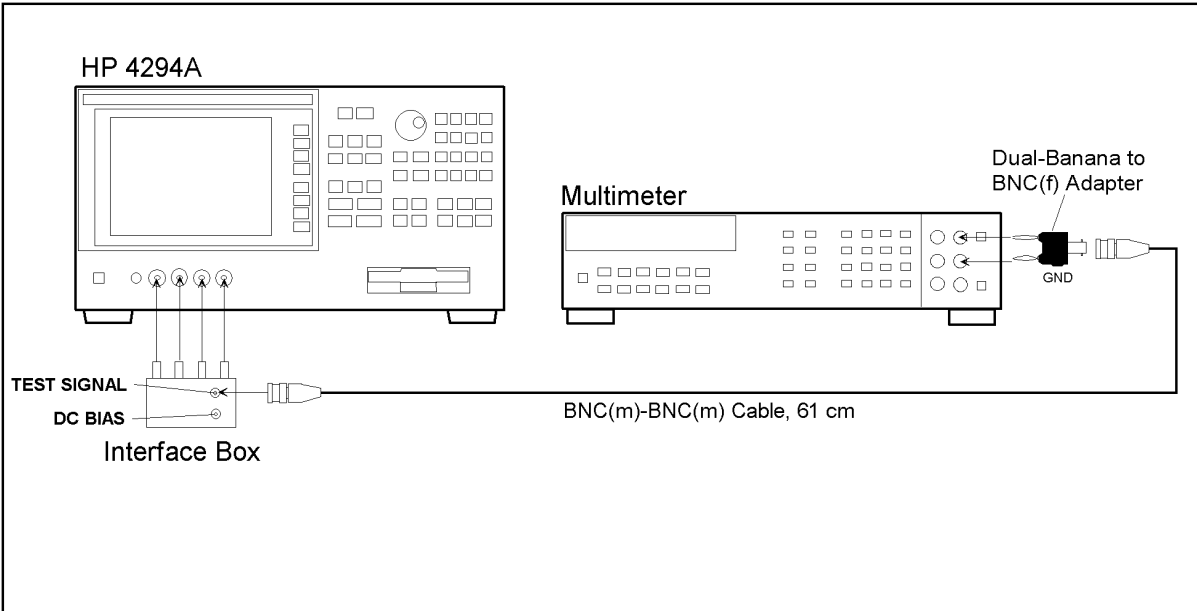
Description	Recommended Model
Multimeter	3458A
Power Meter	437B, 438A, E4418A/B, or E4419A/B
Power Sensor	8482A
Two-way Power Splitter	11667A
61 cm BNC(m) to BNC(m) Cable	p/n 8120-1839
7 mm-N(m) Adapter	11525A
Dual Banana-BNC(f) Adapter	p/n 1251-2277
N(m)-BNC(m) Adapter	p/n 1250-0077
4TP-BNC Interface Box	p/n 04294-61002
OPEN Termination	42090A
N(m)-Termination, 50 Ω	909C Opt.012

Procedure

Accessory: Nothing, 40 Hz to 100 kHz

1. Connect the equipment as shown in Figure 2-2.

Figure 2-2 OSC Level Accuracy Test Setup 1



4294ase02002

2. Press **Reset** key (blue,⇒) to initialize the multimeter, then Set it as follows.
 - a. Press **[ACV]** to set the measurement mode to AC voltage.
 - b. Press **S**(blue - **N Rdgs/Trig**),↓,↓,↓ to display SETACV.
 - c. Press ⇒,↓,↓,↓ to display SYNC, then press **[Enter]**
 - d. Press **[NPLC]** - **[1]** - **[0]** - **[0]** - **[Enter]**
3. Press **[Preset]** to initialize the 4294A. Then set the controls as follows.

Setting	Operation
Frequency Span: 0 Hz	[Span] - [0] - [×1]
Center Frequency: 1 kHz	[Center] - [1] - [k/m]
OSC Level: 1 V	[Source] - LEVEL - [1] - [×1]
OSC Level Monitor: ON	[Display] - OSC MON
Number of Points	[Sweep] - NUMBER OF POINTS - [2] - [×1]

4. Press **[Trigger]** - **Single** for a single sweep measurement:
5. Record the multimeter reading and the OSC Level Monitor Reading to the calculation sheet.
6. Calculate the monitor accuracy according to the calculation sheet, and record the monitor accuracy into the calculation sheet.

NOTE OPEN Reading is recorded in the Step22.

7. Confirm that the monitor accuracy is within the monitor accuracy limit.

NOTE If the monitor accuracy is beyond the limit, OSC Level Test fails.

8. Repeat from Step 4 to 7 for all OSC level and frequency setting in Table 2-1

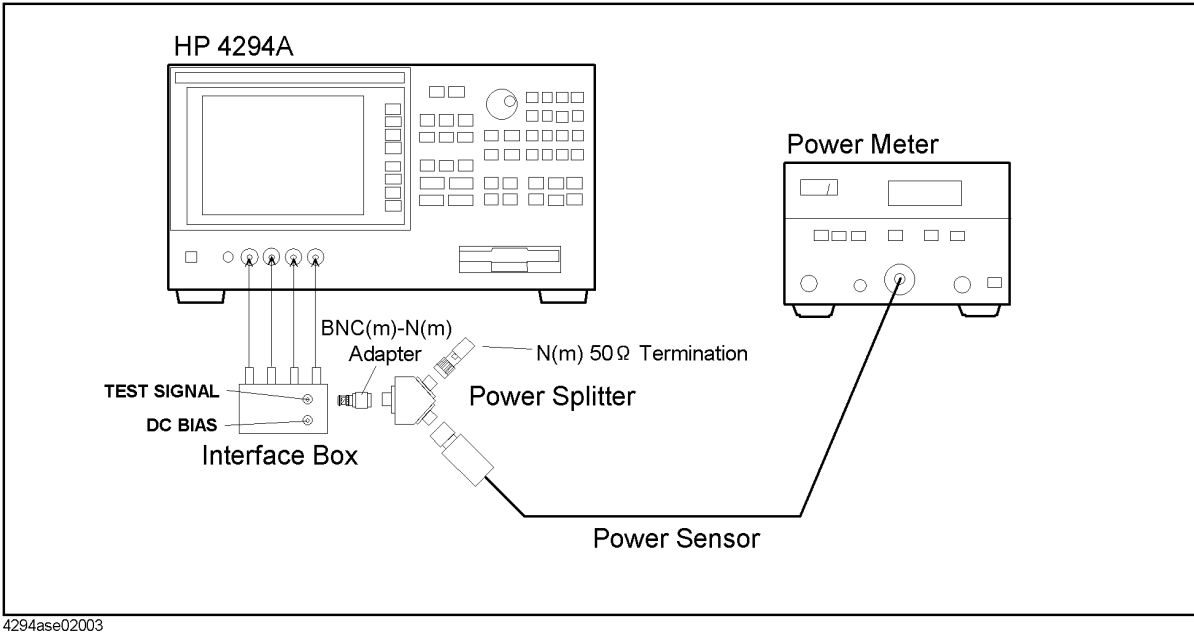
Table 2-1 OSC Level Accuracy Test (Interface box) Settings 1

OSC Level	Frequency
1.0 V	1 kHz
	100 kHz
0.5 V	40 Hz
	1 kHz
	10 kHz
	100 kHz
0.25 V	1 kHz
	100 kHz
0.125 V	1 kHz
	100 kHz
0.064 V	1 kHz
	100 kHz
0.016 V	1 kHz
	100 kHz

Accessory: Nothing, 1 MHz to 110 MHz

9. Connect the power sensor to the power meter. Calibrate the power meter for the power sensor.
10. Set the power meter measurement mode to “Watt”
11. Disconnect the BNC(m)-BNC(m) Cable from the interface box, and connect the equipment as shown in Figure 2-3.

Figure 2-3 OSC Level Accuracy Test Setup 2



4294ase02003

12. Set the 4294A as follows.

Setting	Operation
Center Frequency: 1 MHz	[Center] - [1] - [M/μ]
OSC Level: 0.75 V	[Source] - LEVEL - [.] - [7] - [5] - [×1]

NOTE The OSC level must be set to 0.75V because impedance mismatching occurs between the 4294A and the power sensor. The calculation sheet and the test record say the OSC level is 0.5 V.

13. Press **[Trigger] - Single** for a single sweep measurement:
14. Record the following values according to the calculation sheet.
- a. OSC level monitor reading
 - b. Power meter reading
 - c. OSC level calculated from the power meter reading.
 - d. OSC level monitor accuracy.
15. Confirm that the OSC level monitor accuracy is within the monitor accuracy limit.

NOTE If the monitor accuracy is beyond the limit, OSC Level Test fails.

16. Repeat from Step 13 to 15 for all frequency settings in Table 2-2

Table 2-2 OSC Level Accuracy Test (Interface box) Settings 2

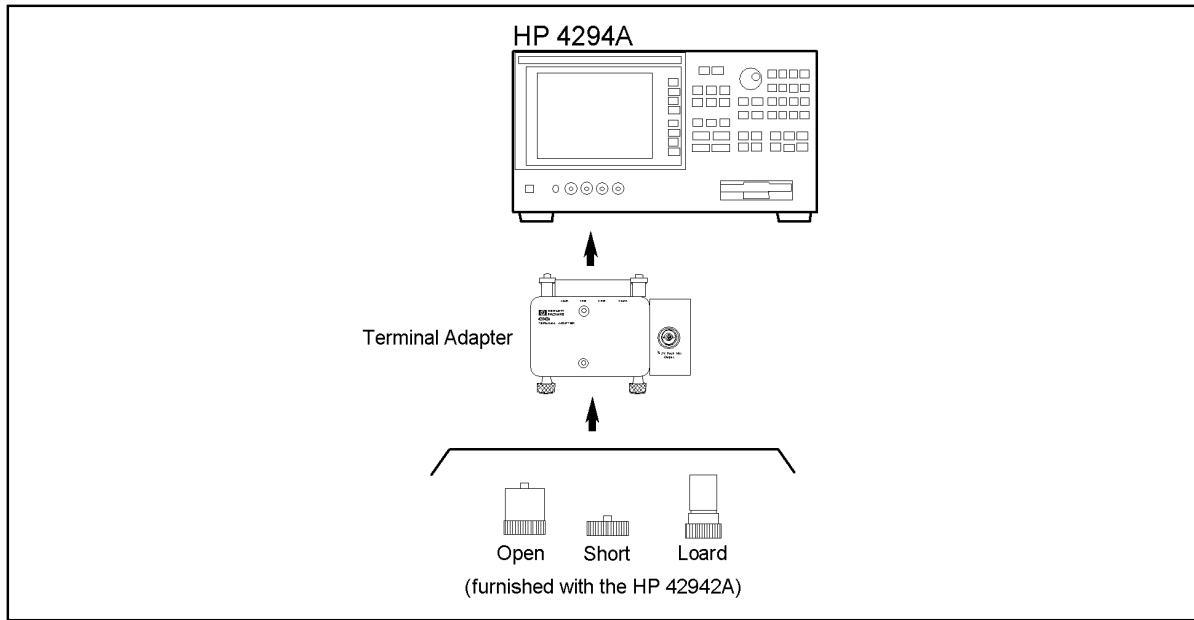
Frequency
1 MHz
10 MHz
15 MHz
16 MHz
50 MHz
110 MHz

17. Disconnect the all test equipment from the 4294A, then connect the OPEN termination directly to the 4294A UNKNOWN terminals.
18. Press **[Source] - LEVEL - [.] - [5] - [×1]** to set the 4294A OSC level to 0.5 V.
19. Press **[Trigger] - Single** for a single sweep measurement:
20. Read the level monitor reading for all OSC level and frequency setting in Table 2-2, then record them to the OPEN Reading column in the calculation sheet.
21. Press **[Trigger] - Single** for a single sweep measurement:
22. Read the level monitor reading for all OSC level and frequency setting in Table 2-1, then record them to the OPEN Reading column in the calculation sheet.
23. Calculate the test results according to the calculation sheet, then record them to the test record.

With 42942A Terminal Adapter

24. Disconnect the all test equipment from the 4294A, then connect the equipment as shown in Figure 2-4

Figure 2-4 42942A Setup



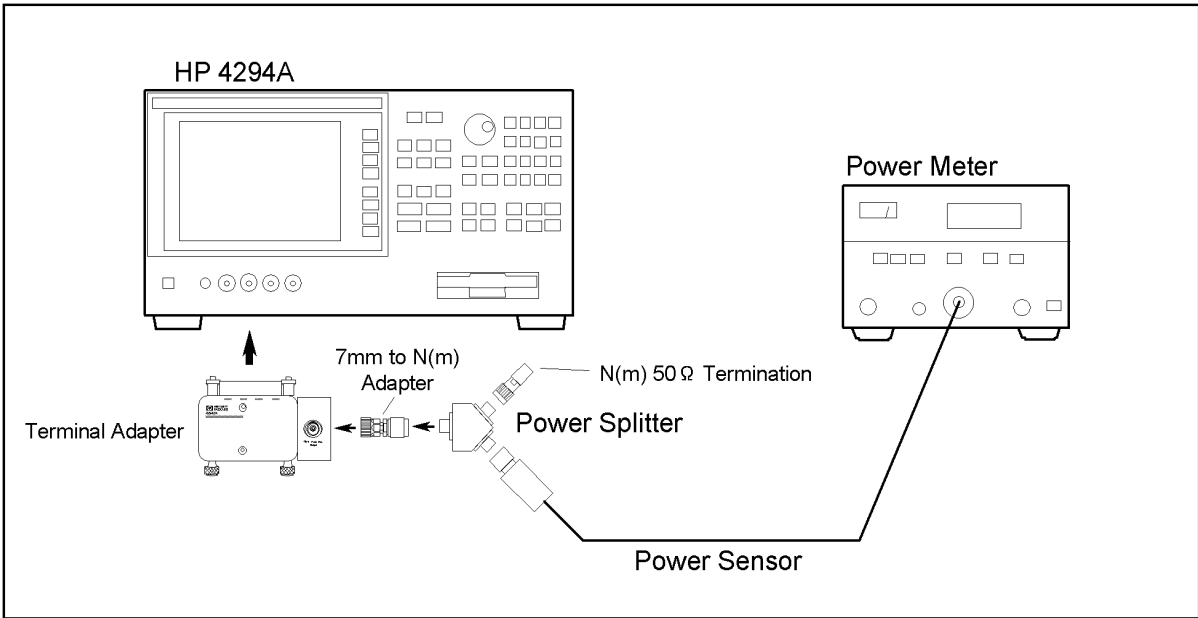
4294ase02010

25. Setup the 42942A as follows.

- Press **[Cal], Adapter, 7mm 42942A, SETUP**.
- Connect the OPEN termination furnished with the 42942A to the 7mm connector.
- Press **PHASE COMP** to measure the phase compensation data.
- Press **OPEN** to measure the open compensation data.
- Connect the SHORT termination furnished with the 42942A instead of the OPEN termination.
- Press **SHORT** to measure the short compensation data.
- Connect the 50 Ω termination furnished with the 42942A instead of the SHORT termination.
- Press **LOAD** to measure the load compensation data.
- Press **done** to activate the measured compensation data.

26. Connect the instruments as shown in Figure 2-5.

Figure 2-5 OSC Level Accuracy Test Setup 3



27. Set the 4294A as follows.

Setting	Operation
Center Frequency: 1 MHz	[Center] - [1] - [M/m]
OSC Level: 0.75 V	[Source] - LEVEL - [.] - [7] - [5] - [\times1]

NOTE

The OSC level must be set to 0.75V because a impedance mismatch occurs between the 4294A and the power sensor.

28. Press **[Trigger]** - **Single** for a single sweep measurement:
29. Record the following values according to the calculation sheet.
- a. OSC level monitor reading
 - b. Power meter reading
 - c. OSC level calculated from the power meter reading.
 - d. OSC level monitor accuracy.
30. Confirm that the monitor accuracy is within the monitor accuracy limit.

NOTE

If the monitor accuracy is beyond the limit, OSC Level Test fails.

Performance Test
Performance Test

31. Repeat from Step 28 to 30 for all frequency settings in Table 2-3

Table 2-3 **OSC Level Accuracy Test (Interface box) Settings 3**

Frequency
1 MHz
10 MHz
15 MHz
16 MHz
50 MHz
110 MHz

32. Disconnect the test equipment from the 7mm connect, then connect the OPEN termination to the 7mm connector.

33. Press **[Source] - LEVEL - [.] - [5] - [×1]** to set the 4294A OSC level to 0.5 V.

34. Press **[Trigger] - Single** for a single sweep measurement:

35. Read the level monitor reading for all OSC level and frequency setting in Table 2-3, then record them to the calculation sheet.

36. Calculate the test results according to the calculation sheet, then record them to the test record.

DC Bias Monitor Accuracy Test

This test checks the accuracy of the DC bias monitor.

Specification

- Voltage Monitor Accuracy:

$\pm[0.2\% + (5 + 0.3 \times |I_{\text{mon}}(\text{mA})|) \text{ mV}]$
at $(23 \pm 5)^\circ\text{C}$
- Current Monitor Accuracy:

$\pm[1\% + (0.5 + |I_{\text{mon}}(\text{mV})| / 10000) \text{ mA}]$
at $(23 \pm 5)^\circ\text{C}$

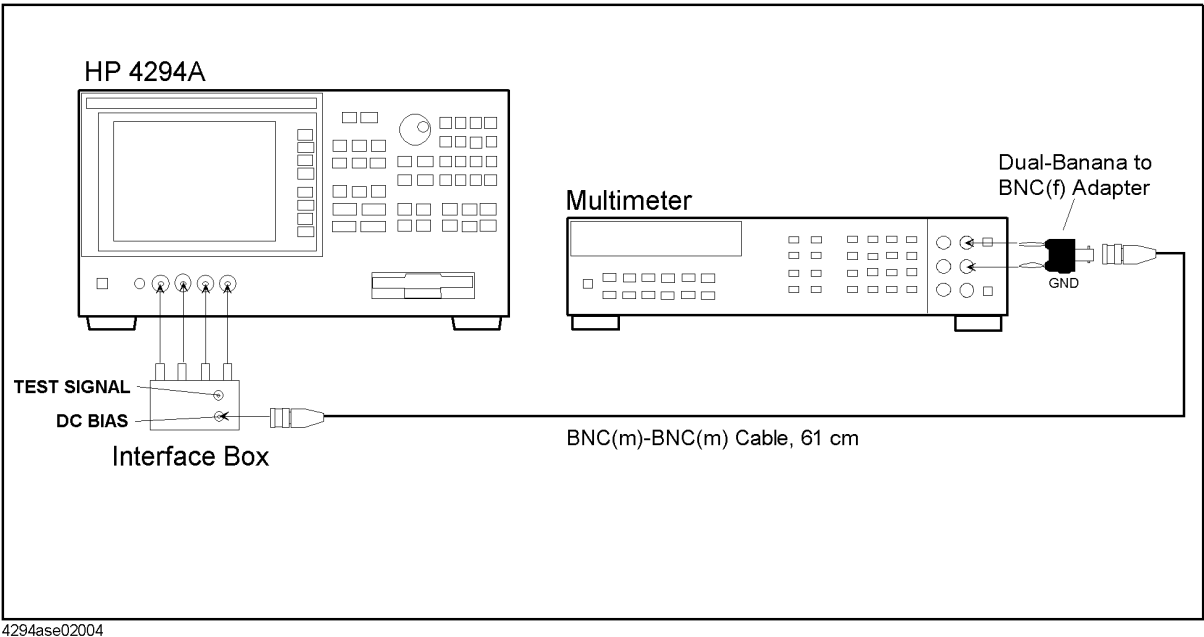
Test Equipment

Description	Recommended Model
Multimeter	3458A
61 cm BNC(m)-BNC(m) Cable	p/n 8120-1839
Dual Banana-BNC(f) Adapter	p/n 1251-2277
4TP-BNC Interface Box	p/n 04294-61002

Procedure

1. Connect the equipment as shown in Figure 2-6

Figure 2-6 DC Bias Monitor Accuracy Test (voltage) Setup



2. Press **Reset** key (blue - =>) to initialize the multimeter, then Set it as follows.
- a. Press **[DCV]** to set the measurement mode to DC voltage.

Performance Test
Performance Test

- b. Press **[NPLC]** - **[1]** - **[0]** - **[0]** - **[Enter]**.
3. Press **[Preset]** to initialize the 4294A, then set it as follows.

Setting	Operation
Adapter: None	[Cal] - ADAPTER - NONE
OSC Level: 0 V*1	[Source] - [0] - [×1]
DC Bias: On	[Source] - BIAS MENU - BIAS
DC Bias Mode: Voltage	[Source] - BIAS MENU - MODE - VOLT
DC Bias Monitor: Voltage	[Display] - BIAS MON - VOLT
DC Bias Level: 0 V	[Source] - BIAS MENU - VOLTAGE LEVEL - [0] - [×1]

*1. OSC level is set to 5 mV automatically.

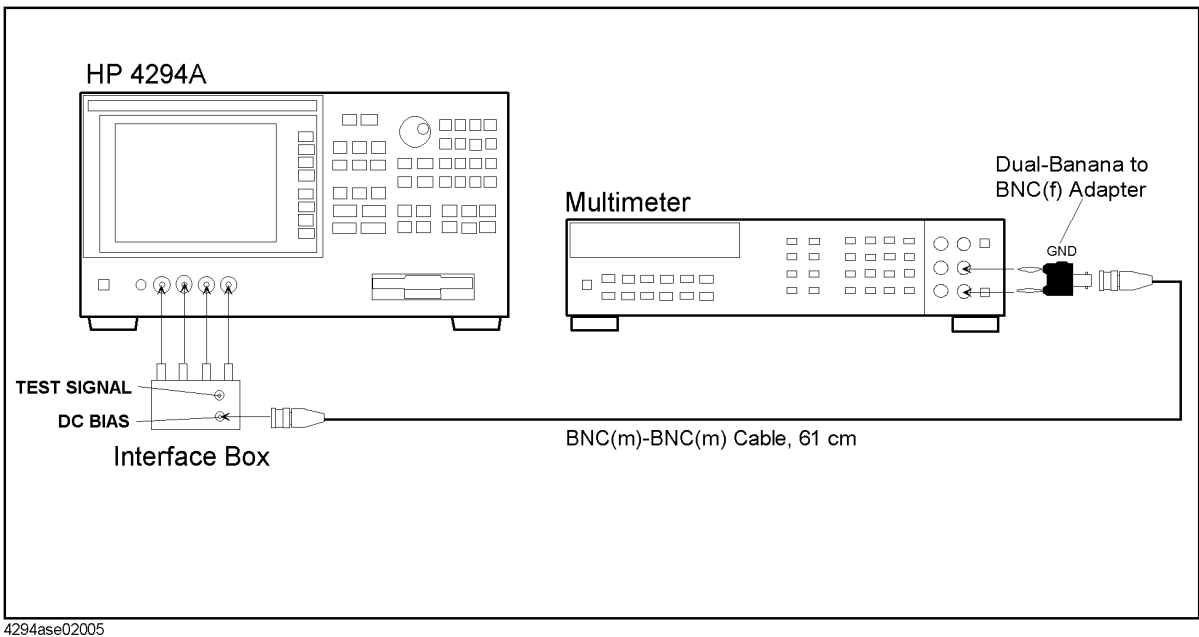
4. Press **[Trigger]** - **Single** for a single sweep measurement:
5. Record the multimeter reading and the DC Bias monitor reading on the calculation sheet.
6. Calculate the result according to the calculation sheet, then record it on the performance test record.
7. Perform Step 5 and 6 for all setting in Table 2-4

Table 2-4 **DC Bias Monitor Accuracy Test (voltage) Setting**

Bias Level
0 V
25 V
40 V
-25 V
-40 V

8. Connect the equipment as shown in Figure 2-7

Figure 2-7 DC Bias Monitor Accuracy Test (current) Setup



9. Press **Reset** key (blue - \Rightarrow) to initialize the multimeter, then Set it as follows.
- a. Press **[DCI]** to set the measurement mode to DC current.
 - b. Press **[NPLC] - [1] - [0] - [0] - [Enter]**.
10. Press **[Preset]** to initialize the 4294A, then set it as follows.

Setting	Operation
OSC Level: 0 V ^{*1}	[Source] - [0] - [×1]
DC Bias Mode: Voltage	[Source] - BIAS MENU - MODE - VOLT
DC Bias Monitor: Current	[Display] - BIAS MON - CURRENT
DC Bias Level: 0 V	[Source] - BIAS MENU - VOLTAGE LEVEL - [0] - [×1]

*1. OSC level is set to 5 mV automatically.

11. Perform as follows to adjust the actual 4294A OSC output level to the test point.
- a. Set the DC Bias level to “DC Bias Setting 1” column in the calculation sheet.
 - b. Press **[Trigger] - Single** for a single sweep measurement:
 - c. Record the multimeter reading to “Multimeter reading 1” column in the calculation sheet.
 - d. Calculate “DC Bias Setting 2” according to the calculation sheet, then set the DC Bias level to it.

NOTE

When test point is “0 mA”, Step b and c is not required.

Performance Test
Performance Test

12. Press **[Trigger]** - **Single** for a single sweep measurement.
13. Record the multimeter reading and the DC Bias monitor reading, then record them on the calculation sheet.
14. Calculate the result according to the calculation sheet, then record it on the performance test record.
15. Perform Step 11 and 14 for all setting in Table 2-5

Table 2-5 **DC Bias Monitor Accuracy Test (current) Setting**

Bias Level
0 mA
20 mA
100 mA
-20 mA
-100 mA

DC Bias Level Accuracy Test

This test checks the accuracy of the DC bias level at several level.

Specification

Voltage Monitor Accuracy: $\pm[0.1 \% + (5 + 30 \times |I_{mon}(mA)|) \text{ mV}]$
at $(23 \pm 5) ^\circ\text{C}$
Current Monitor Accuracy: $\pm[2 \% + (0.2 + |I_{mon}(\text{mV})| / 20) \text{ mA}]$
at $(23 \pm 5) ^\circ\text{C}$

Test Equipment

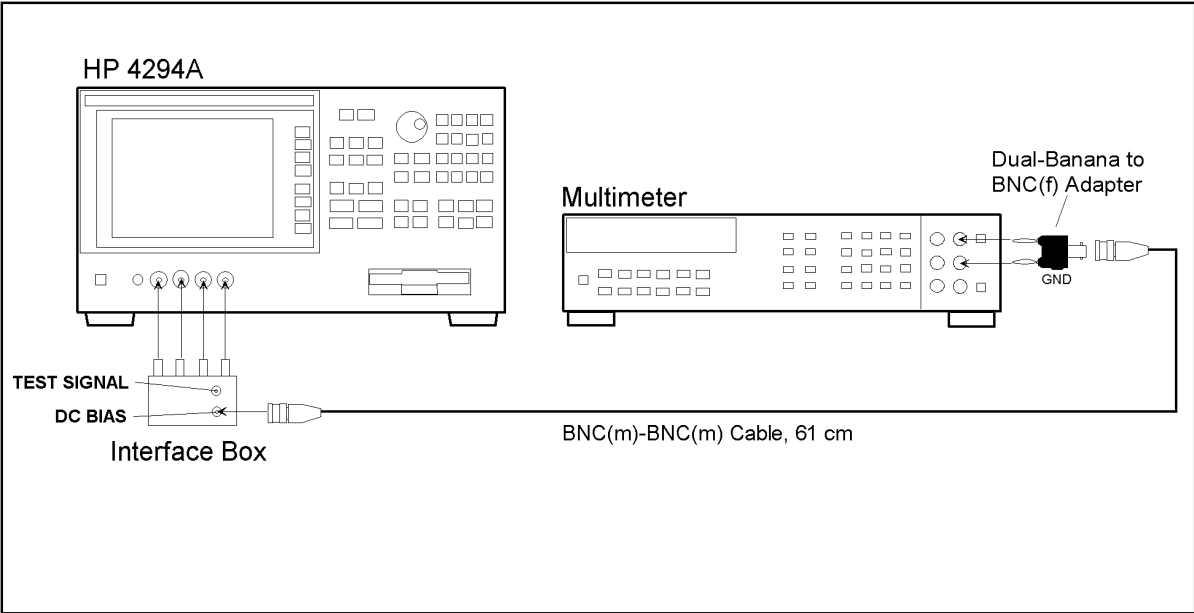
Description	Recommended Model
Multimeter	3458A
SHORT Termination	42091A
61 cm BNC(m)-BNC(m) Cable	p/n 8120-1839
Dual Banana-BNC(f) Adapter	p/n 1251-2277
4TP-BNC Interface Box	p/n 04294-65002

Procedure

NOTE Calibration factor must be calculated in DC Bias Monitor Accuracy Test before this test is performed.

1. Connect the equipment as shown in Figure 2-8

Figure 2-8 DC Bias Level Accuracy Test (voltage) Setup



4294ase02004

2. Press **Reset** key (blue - \Rightarrow) to initialize the multimeter, then Set it as follows.
 - a. Press **[DCV]** to set the measurement mode to DC voltage.
 - b. Press **[NPLC]** - **[1]** - **[0]** - **[0]**.
3. Press **[Preset]** to initialize the 4294A, then set it as follows.

Setting	Operation
Adapter: None	[Cal] - ADAPTER - NONE
OSC Level: 0 V	[Source] - [0] - [$\times 1$]
DC Bias: On	[Source] - BIAS MENU - BIAS
DC Bias Mode: Voltage	[Source] - BIAS MENU - MODE - VOLT
DC Bias Monitor: Voltage	[Display] - BIAS MON - VOLT
DC Bias Level: 0 V	[Source] - BIAS MENU - VOLTAGE LEVEL - [0] - [$\times 1$]

4. Press **[Trigger]** - **Single** for a single sweep measurement:
5. Record the multimeter reading on the calculation sheet.
6. Calculate the result according to the calculation sheet, then record it on the performance test record.
7. Perform Step 5 and 6 for all setting in Table 2-6.

Table 2-6 DC Bias Monitor Accuracy Test (voltage) Setting

Bias Level
0 V
25 V
40 V
–25 V
–40 V

8. Disconnect the all test equipment from the 4294A, then connect the SHORT Termination to the 4294A UNKNOWN Terminal.
9. Press **[Preset]** to initialize the 4294A, then set it as follows.

Setting	Operation
OSC Level: 0 V	[Source] - [0] - [×1]
DC Bias Mode: Current	[Source] - BIAS MENU - MODE - CURRENT
DC Bias Monitor: Current	[Display] - BIAS MON - CURRENT
DC Bias Level: 0 A	[Source] - BIAS MENU - CURRENT LEVEL - [0] - [×1]

10. Press **[Trigger]** - **Single** for a single sweep measurement:
11. Record the DC Bias Monitor reading to “DC Bias Reading 1” on the calculation sheet.
12. Calculate the result according to the calculation sheet, then record it on the calculation sheet.
13. Perform Step 11 and 12 for all setting in Table 2-7

Table 2-7 DC Bias Monitor Accuracy Test (current) Setting

Bias Level
0 mA
20 mA
100 mA
–20 mA
–100 mA

Measurement Accuracy Test

This test checks the DC bias level of the stimulus signal at several frequencies from 40 Hz to 110 MHz.

Specification

Measurement Accuracy: Basic Accuracy: 0.08%

See the *Specifications on Operation Manual* for details.

Test Equipment

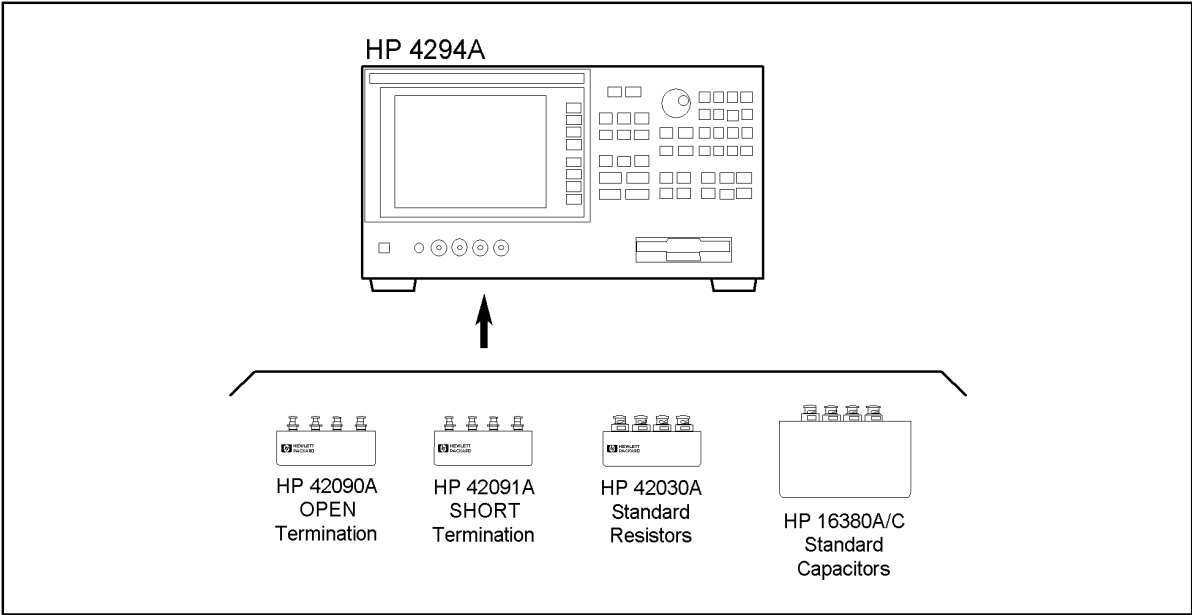
Description	Recommended Model
Standard Capacitor Set	16380A
Standard Capacitor Set	16380C
Standard Resistor Set	42030A
Terminal Adapter	42942A
Performance Test Kit	16190A
100 Ω Resistor ^{*1}	p/n 04294-61001
1m Test Leads	16048G
2m Test Leads	16048H

*1. A attachment to the 4294A

Procedure

1. Record the 16380A, 16380C, 42030A, 16190A calibration values on the calculation sheet.
2. Press **[Preset]** to initialize the 4294A.
3. Press **[Cal]**, then confirm that Adapter is set to NONE. If it is not set to NONE, Press **ADAPTER - NONE**.
4. Connect the OPEN Termination to the 4294A UNKNOWN Terminal as shown in Figure 2-9.

Figure 2-9 Measurement Accuracy Test Setup (Accessory: None)



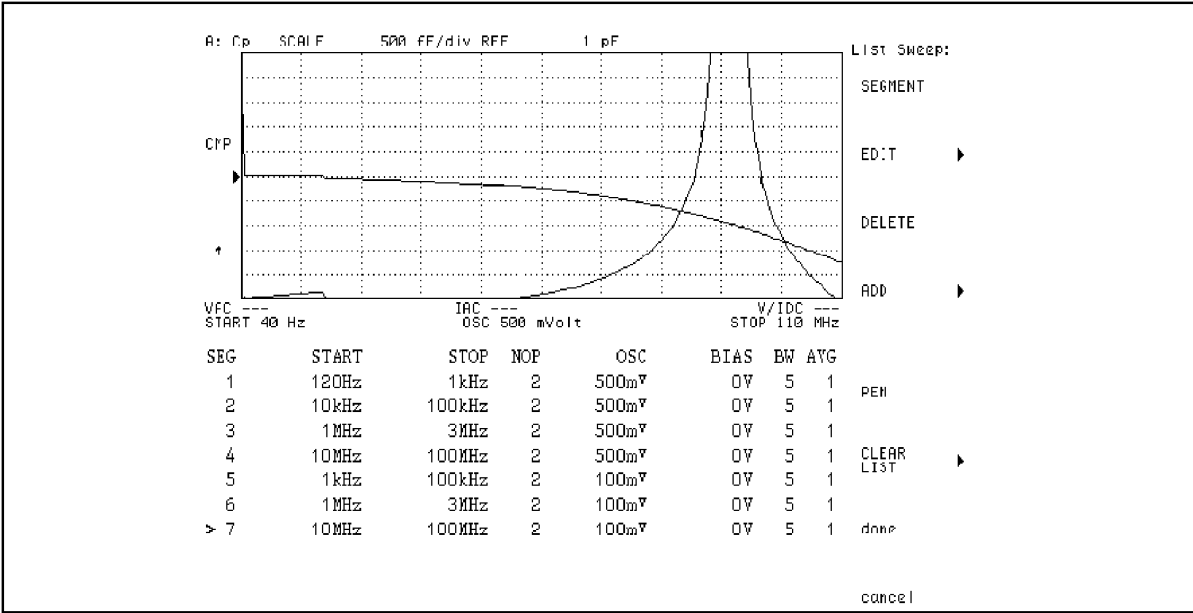
4294ase02006

5. Press **[Cal]** - **FIXTURE COMPEN** - **OPEN**
6. Connect the SHORT termination instead of the OPEN termination
7. Press **[Cal]** - **FIXTURE COMPEN** - **SHORT**
8. Press **[Meas]** - **more 1/3** - **Cp-D** to set the 4294A Measurement mode to Cp-D.
9. Create the sweep list shown in Figure 2-10. Segment 1 is added by the following procedure.
 - a. Press **[Sweep]** - **EDIT LIST** - **[ADD]** to add a segment to the sweep list.
 - b. Edit the segment as follows.

Setting	Operation
Start Frequency: 40 Hz	START - [4] - [0] - [×1]
Stop Frequency: 1 kHz	STOP - [1] - [k/m]
Number of Point: 2	NUMBER OF POINT - [2]
OSC level: 500 mV	more 1/3 - OSC LEVEL - [5] - [0] - [0] - [k/m]
Bandwidth	more 2/3 - BANDWIDTH - 5 PRECISE

NOTE Press the START or STOP Softkey. Do NOT press the front panel key printed “Start” or “Stop”.

Figure 2-10 Sweep List for Measurement Accuracy Test



4294ase02011

- c. Press **done**.
10. Press **done** to save the sweep list menu.
11. Press **TYPE - LIST** to set the sweep type to the list sweep.
12. Connect the 1 pF standard capacitor to the 4294A UNKNOWN Terminal as shown in Figure 2-9 on page 39.
13. Press **[Trigger] - SINGLE** to make a measurement.
14. Press **[Copy] - SELECT CONTENTS - LIST VALUE** to show the list as shown in Figure 2-11.

Figure 2-11 Measurement Value List

STIMULUS [Hz]	A: Cp [F]	B: D [U]	
120	978.066f	145.336m	OSC Level 0.5 V
1k	1.02896p	28.6196m	
10k	1.0062p	-3.00156m	
100k	1.00169p	-68.4586u	
1M	999.758f	-614.754u	
3M	1.0014p	768.257u	
10M	997.727f	12.2228m	
100M	-376.681f	205.72m	OSC Level 0.1 V
1k	946.577f	68.6325m	
100k	1.00263p	2.61393m	
1M	999.914f	-875.935u	
3M	1.0011p	894.137u	
10M	997.827f	12.1325m	
100M	-376.631f	205.537m	

4294ase02013

2. Performance Test

15. Record the 4294A reading on the calculation sheet for all setting in Table 2-8, then Calculate the test result.

Table 2-8 Measurement Accuracy Test(Accessory: None, Standard Capacitor) Setting

Standard Capacitor	OSC Level	Frequency
1 pF	0.5 V	1 MHz
		3 MHz
10 pF	0.5 V	1 kHz
		1 MHz
		3 MHz
		10 MHz
	0.1 V	1 kHz
100 pF	0.5 V	1 kHz
		100 kHz
		1 MHz
		3 MHz
		10 MHz
	0.1 V	1 kHz
		100 kHz
		1 MHz
		3 MHz
		10 MHz
1000 pF	0.5 V	1 kHz
		10 kHz
		100 kHz
	0.1 V	1 kHz
0.01 μ F	0.5 V	120 Hz
		1 kHz
		10 kHz
	0.1 V	1 kHz
0.1 μ F	0.5 V	120 Hz
		1 kHz
		10 kHz
	0.1 V	1 kHz
1 μ F	0.5 V	120 Hz
		1 kHz
	0.1 V	1 kHz

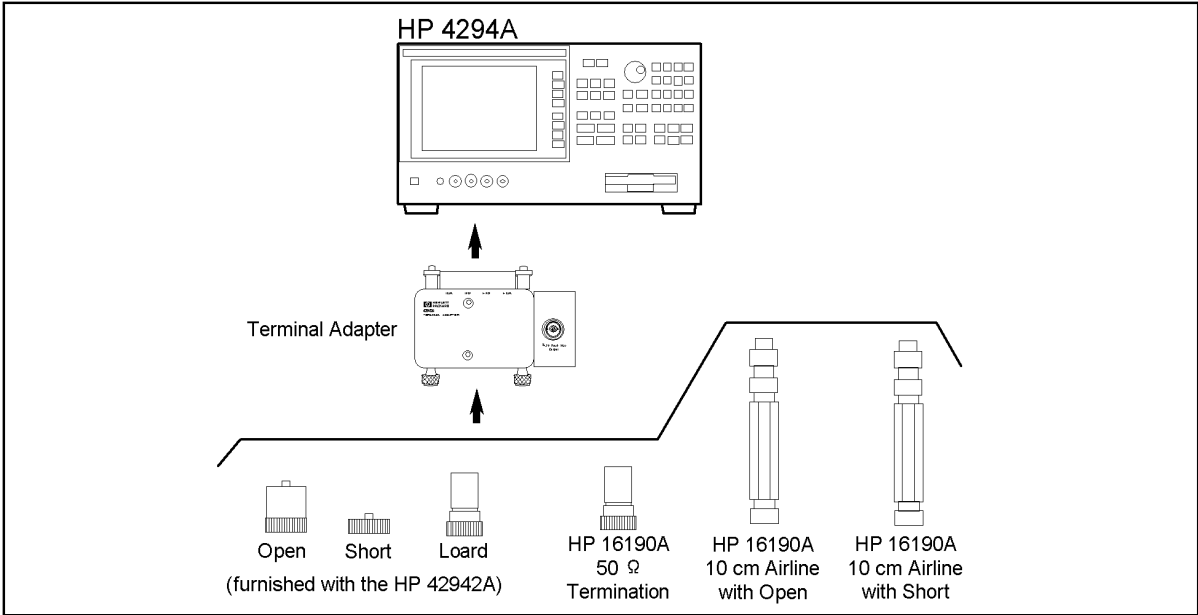
- 16. Connect the 10 Ω standard resistor to the 4294A UNKNOWN Terminal as shown in Figure 2-9 on page 39.
- 17. Press **[Meas] - R-X** to set the measurement mode to **R-X**.
- 18. Press **[Trigger] - SINGLE** to make a measurement.
- 19. Record the 4294A reading on the calculation sheet for all setting in Table 2-9, then calculate the test result.

Table 2-9 Measurement Accuracy Test(Accesory:None, Standard Resister) Setting

Standard Capacitor	OSC Level	Frequency
10 Ω	0.5 V	1 kHz
	0.1 V	1 kHz
1 Ω	0.5 V	1 kHz
	0.1 V	1 kHz
100 mΩ	0.5 V	1 kHz
	0.1 V	1 kHz
10 mΩ	0.5 V	1 kHz
	0.1 V	1 kHz

- 20. Disconnect all the equipment from the 4294A, then connect the equipment as shown in Figure 2-12.

Figure 2-12 Measurement Accuracy Test(Accessory: 42942A Terminal Adapter)



4294ase02009

Performance Test
Performance Test

21. Press **[Cal] - Adapter - 7mm 42942A** to set the adapter to the 42942A.
22. Setup the 4294A as follows.

NOTE

If Setup is completed in OSC level accuracy test, this operation is not required.

- a. Press **SETUP**.
 - b. Connect the OPEN termination furnished with the 42942A to the 7mm connector.
 - c. Press **PHASE COMP** to measure the phase compensation data.
 - d. Press **OPEN** to measure the open compensation data.
 - e. Connect the SHORT termination furnished with the 42942A instead of the OPEN termination.
 - f. Press **SHORT** to measure the short compensation data.
 - g. Connect the 50 Ω termination furnished with the 42942A instead of the SHORT termination.
 - h. Press **LOAD** to measure the load compensation data.
 - i. Press **done** to activate the measured compensation data.
23. Press **[Meas] - |Z|** to set the measurement mode.
 24. Press **[B] - [Format] - PHASE UNIT** to set the phase display unit to radian.
 25. Connect the 50 Ω Termination furnished with the 16190A to the 7mm connector.
 26. Press **[Trigger] - Single** to make a measurement.
 27. Record the 4294A reading on the calculation sheet for all setting in Table 2-10, then calculate the test result.

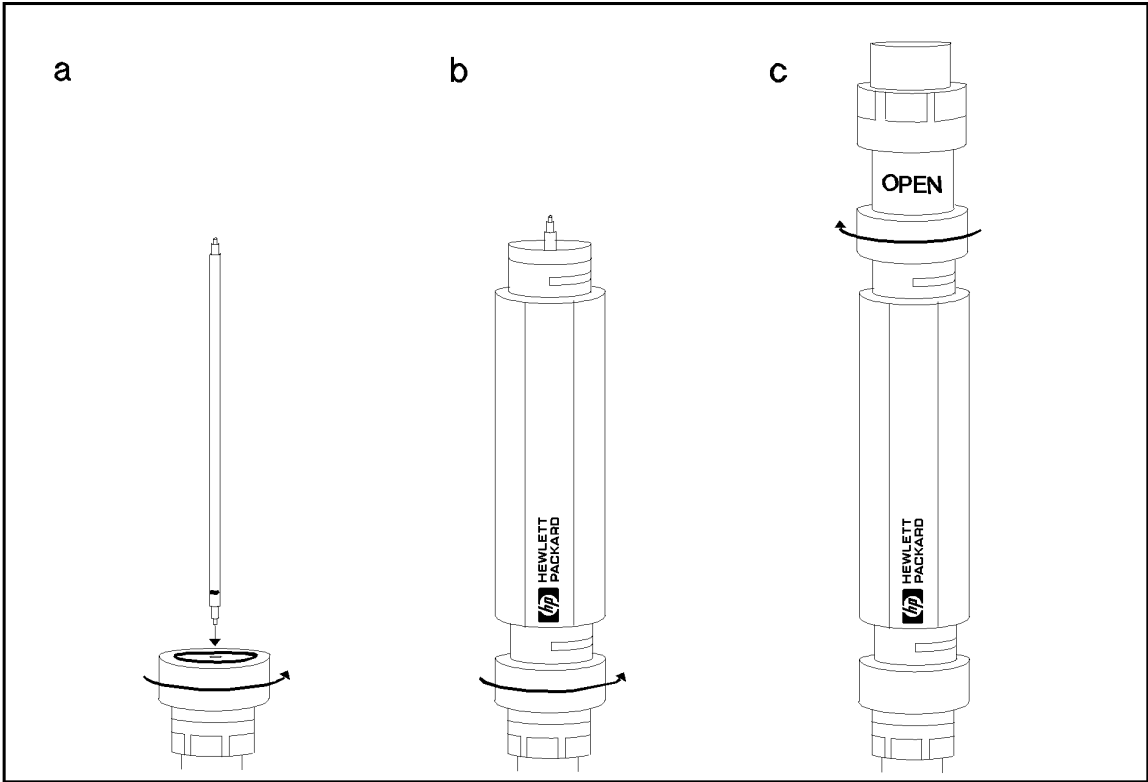
Table 2-10 Measurement Accuracy Test (Accessory: 42942A Terminal Adapter, 50 Ω) Setting

OSC Level	Frequency
0.5 V	1 kHz
	1 MHz
	10 MHz
	100 MHz

28. Connect the 10 cm airline and the OPEN termination to the 7mm connector as follows.(refer to Figure 2-13)
 - a. Fully retract the threads on the test head 7mm connector. Then insert the marked side tip of the airline center conductor into the connector center conductor.
 - b. Gently cover the airline center conductor with the airline outer conductor, with the Agilent logo side down. (To prevent damage, do not let the center conductor scrape the edge of the outer conductor.) Mate the outer conductors. Then tie the connection by the 136 N·cm. (A 1/2 inch open end wrench may be necessary to hold the airline stationary)

- c. Gently inserts the airline center conductor into the open termination center conductor. Mate the outer conductors. Then tie the connection by the 136 N·cm torque.

Figure 2-13 10cm Airline with OPEN Measurement Test Setup



C6S02005

- 29. Press **[Trigger] - Single** to make a measurement.
- 30. Record the 4294A reading on the calculation sheet for all setting in Table 2-11, then calculate the test result.

Table 2-11 Measurement Accuracy Test (Accessory: 42942A Terminal Adapter, SHORT or OPEN Termination) Setting

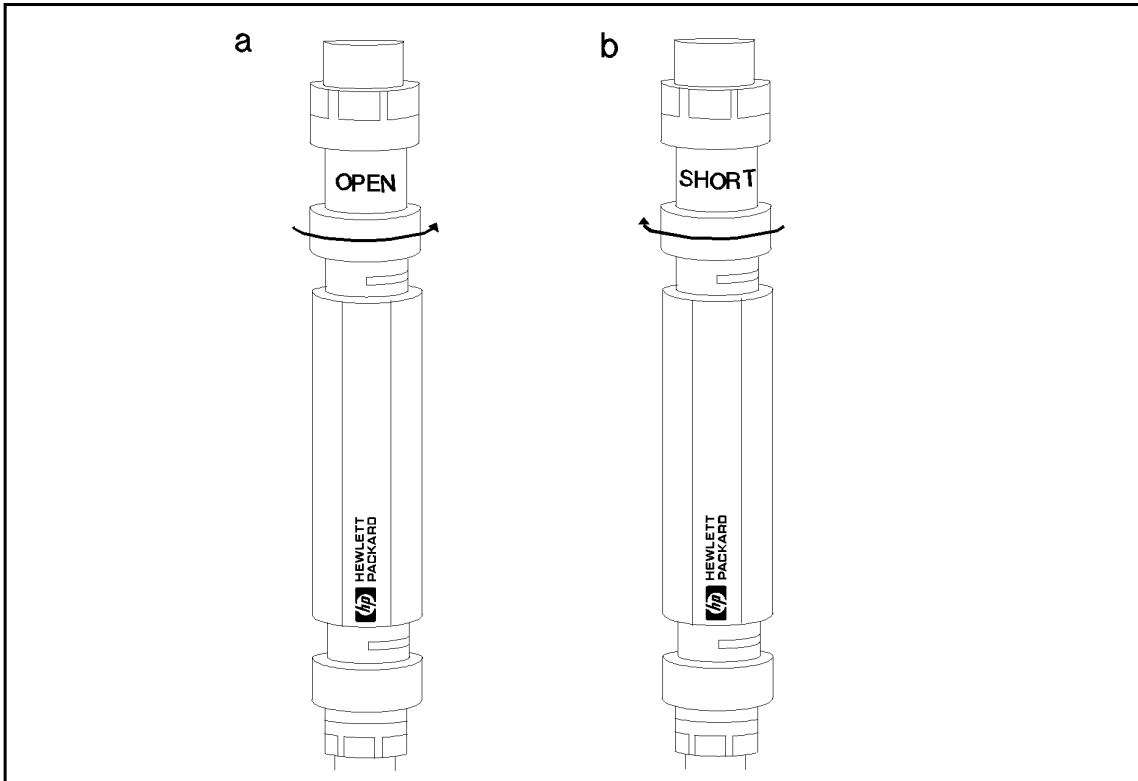
OSC Level	Frequency
0.5 V	1 MHz
	10 MHz
	100 MHz

- 31. Connect the 10cm airline and SHORT termination to the 7mm connector as follows. (refer to Figure 2-14)
 - a. Remove the OPEN termination from the airline.
 - b. Gently inserts the airline center conductor into the short termination center conductor. Mate the outer conductors. Then tie the connection by the 136 N·cm

Performance Test
Performance Test

torque. (A 1/2 inch open end wrench may be necessary to hold the airline stationary.)

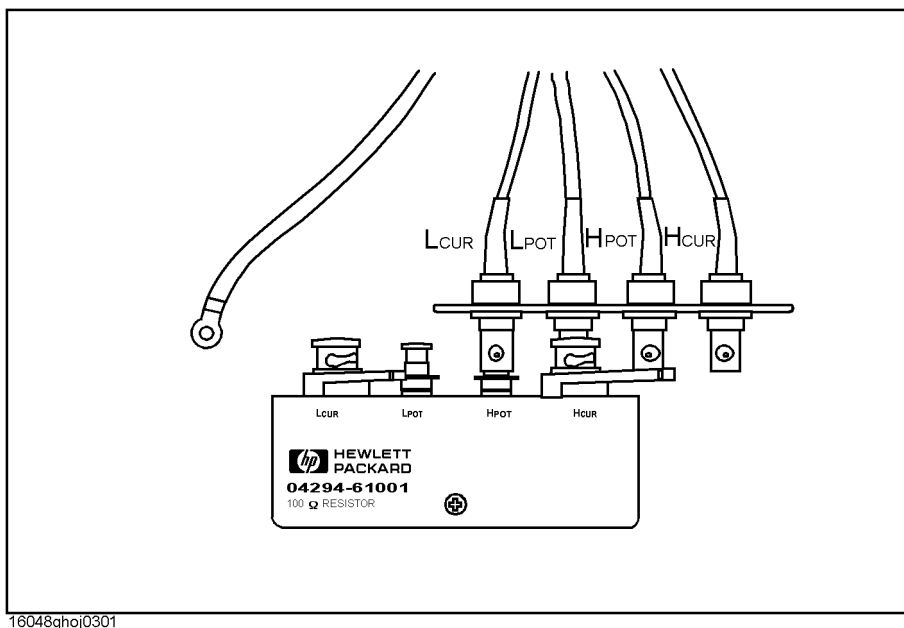
Figure 2-14 10 cm Airline with SHORT Measurement Test Setup



C6S02006

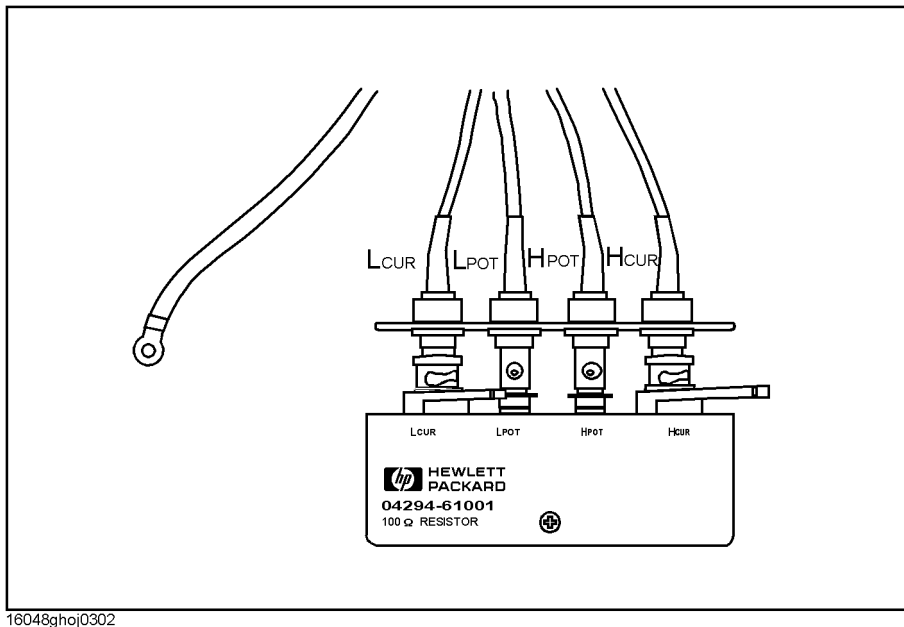
32. Press **[Trigger]** - **Single** to make a measurement.
33. Record the 4294A reading on the calculation sheet for all setting in Table 2-11 on page 45, then calculate the test result.
34. Disconnect all the equipment from the 4294A, then perform the setup as follows
 - a. Connect the 1m Test Leads to the 4294A UNKNOWN Terminal.
 - b. Press **[Cal]** - **ADAPTER - 4TP 1M - SETUP**.
 - c. Connect the 100 Ω Resistor to 1m Test Leads as shown in Figure 2-15.

Figure 2-15 Connection for phase compensation



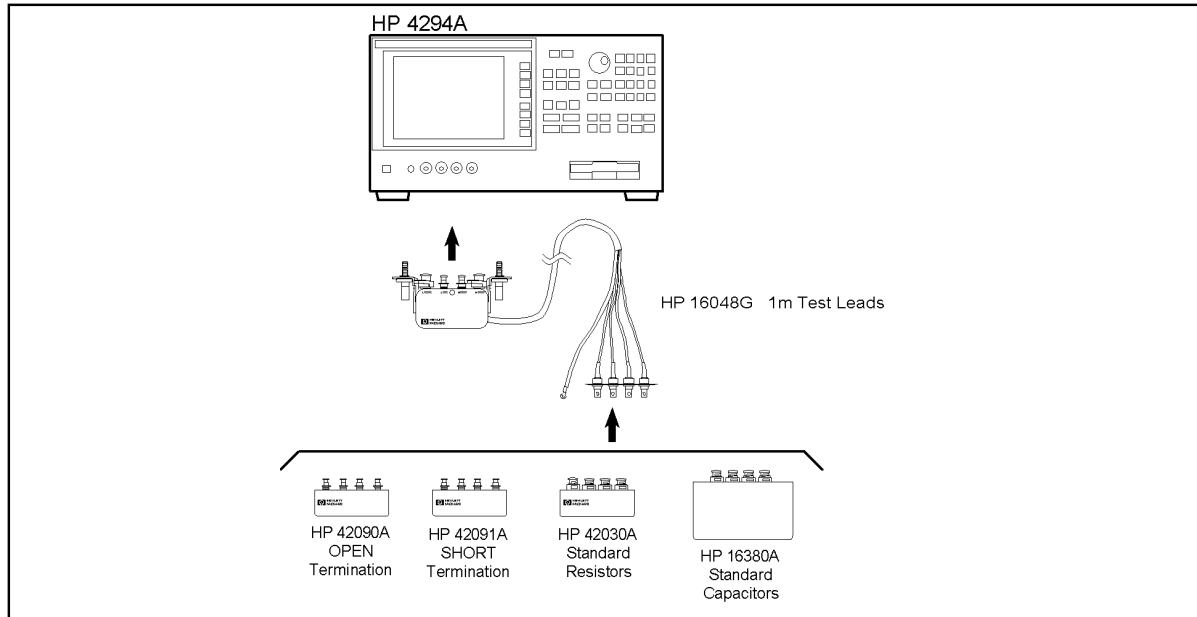
- d. Press **PHASE COMP** to measure the phase compensation data.
- e. Connect the 100 Ω Resistor's all terminals to the test leads as shown in Figure 2-16.

Figure 2-16 Connection for load compensation



- f. Press **LOAD** to measure the load compensation data.
- g. Press **done** to activate the compensation data.

Figure 2-17 Measurement Accuracy Test Setup (Accessory: 1m Test Leads)



4294ase02007

35. Connect the OPEN Termination as shown in Figure 2-17.
36. Press **[Cal] - FIXTURE COMPEN - OPEN**.
37. Connect the SHORT termination instead of the OPEN termination.
38. Press **[Cal] - FIXTURE COMPEN - SHORT**.
39. Connect the 10 pF standard capacitor to the 4294A UNKNOWN Terminal as shown in Figure 2-17.
40. Press **[Meas] - more 1/3 - Cp-D** to set the 4294A Measurement mode to Cp-D.
41. Press **[Trigger] - Single** to make a measurement.
42. Record the 4294A reading on the calculation sheet for all setting in Table 2-12, then Calculate the test result.

Table 2-12 **Measurement Accuracy Test(Accesory:1m Test Leads, Standard Capacitor) Setting**

Standard Capacitor	OSC Level	Frequency
10 pF	0.5 V	1 kHz
		1 MHz
		3 MHz
		10 MHz
100 pF	0.5 V	1 kHz
		100 kHz
		1 MHz
		3 MHz
		10 MHz

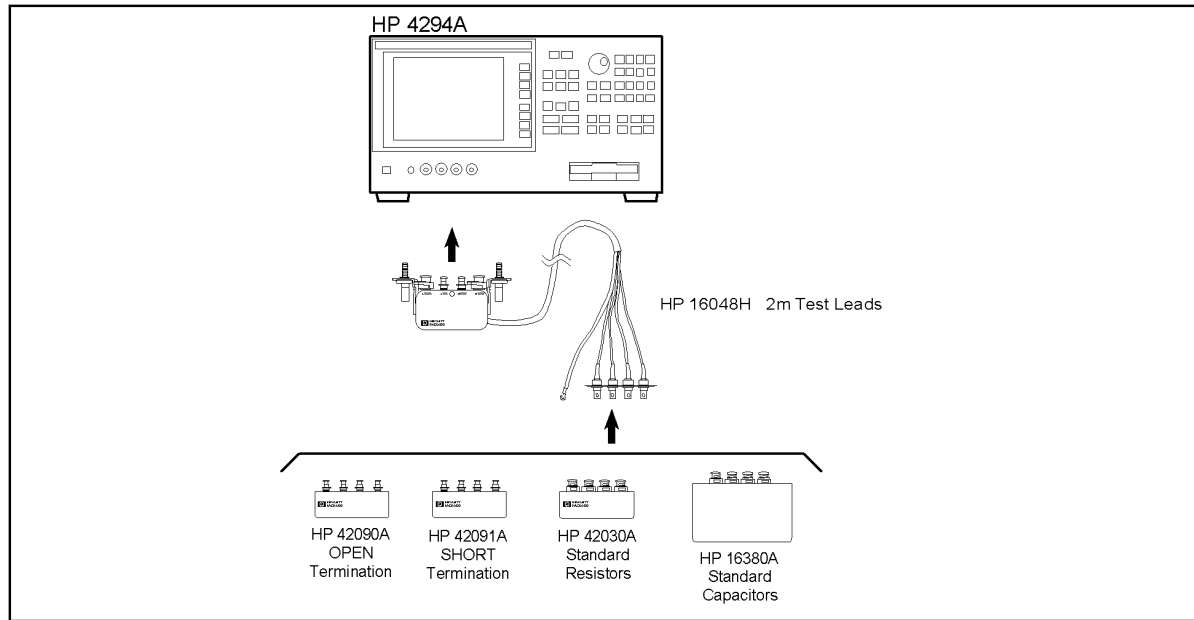
43. Connect the 1 Ω standard resistor as shown in Figure 2-17.
44. Press **[Meas] - R-X** to set the measurement mode to **R-X**.
45. Press **[Trigger] - Single** to make a measurement.
46. Record the 4294A reading on the calculation sheet for all setting in Table 2-13, then Calculate the test result.

Table 2-13 **Measurement Accuracy Test(Accesory:1m Test Leads, Standard Resistor) Setting**

Standard Capacitor	OSC Level	Frequency
1 Ω	0.5 V	1 kHz
100 m Ω	0.5 V	1 kHz

47. Disconnect all the equipment from the 4294A, then perform the setup as follows.
 - a. Connect the 2m Test Leads to the 4294A UNKNOWN Terminal.
 - b. Press **[Cal] - ADAPTER - 4TP 2M - SETUP**.
 - c. Connect the 100 Ω Resistor to 2m Test Leads as shown in Figure 2-15 on page 47.
 - d. Press **PHASE COMP** to measure the phase compensation data.
 - e. Connect the 100 Ω Resistor's all terminals to the test leads as shown in Figure 2-16 on page 47.
 - f. Press **LOAD** to measure the load compensation data.
 - g. Press **done** to activate the compensation data.
48. Connect the Standard capacitor as shown in Figure 2-18.

Figure 2-18 Measurement Accuracy Test Setup (Accessory: 2m Test Leads)



4294ase02008

49. Press **[Cal] - FIXTURE COMPEN - OPEN**
50. Connect the SHORT termination instead of the OPEN termination
51. Press **[Cal] - FIXTURE COMPEN - SHORT**
52. Connect the 10 pF standard capacitor to the 4294A UNKNOWN Terminal as shown in Figure 2-18.
53. Press **[Meas] - more 1/3 - Cp-D** to set the 4294A Measurement mode to Cp-D.
54. Press **[Trigger] - Single** to make a measurement.
55. Record the 4294A reading on the calculation sheet for all setting in Table 2-14, then Calculate the test result.

Table 2-14 **Measurement Accuracy Test(Accesory:2m Test Leads, Standard Capacitor) Setting**

Standard Capacitor	OSC Level	Frequency
10 pF	0.5 V	1 kHz
		1 MHz
		3 MHz
		10 MHz
100 pF	0.5 V	1 kHz
		100 kHz
		1 MHz
		3 MHz
		10 MHz

56. Connect the Standard resistor as shown in Figure 2-18.
57. Press **[Meas] - R-X** to set the measurement mode to **R-X**.
58. Press **[Trigger] - Single** to make a measurement.
59. Record the 4294A reading on the calculation sheet for all setting in Table 2-15, then Calculate the test result.

Table 2-15 **Measurement Accuracy Test(Accesory:2m Test Leads, Standard Resistor) Setting**

Standard Capacitor	OSC Level	Frequency
1 Ω	0.5 V	1 kHz
100 mΩ	0.5 V	1 kHz

Calculation Sheet

OSC Level Accuracy Test

OSC Level Accuracy(Accessory: Nothing, 40 Hz to 100 kHz)

OSC Level [a]	Freq.	Monitor Reading [b]	Multimeter Reading [b]	Monitor Accuracy [b-c]	Monitor Accuracy Limit	OPEN Reading [d]	Test Result [d×c/b-a]
1.0 V	1 kHz	V	V	V	± 0.1001 V	V	mV
	100 kHz	V	V	V	± 0.1001 V	V	mV
0.5 V	40 Hz	V	V	V	± 0.0500 V	V	mV
	1 kHz	V	V	V	± 0.0500 V	V	mV
	10 kHz	V	V	V	± 0.0500 V	V	mV
	100 kHz	V	V	V	± 0.0500 V	V	mV
0.25 V	1 kHz	V	V	V	± 0.0250 V	V	mV
	100 kHz	V	V	V	± 0.0250 V	V	mV
0.125 V	1 kHz	V	V	V	± 0.0125 V	V	mV
	100 kHz	V	V	V	± 0.0125 V	V	mV
0.064 V	1 kHz	V	V	V	± 0.0064 V	V	mV
	100 kHz	V	V	V	± 0.0064 V	V	mV
0.016 V	1 kHz	V	V	V	± 0.0016 V	V	mV
	100 kHz	V	V	V	± 0.0016 V	V	mV

OSC Level Accuracy (Accessory: Nothing, 1 MHz to 110 MHz)

OSC Level [a]	Freq.	Monitor Reading [b]	Power Meter Reading [c]	Calculated OSC level [d] $= 2\sqrt{50 \times c}$	Monitor Accuracy [b-d]	Monitor Accuracy Limit	OPEN Reading [e]	Test Result [e×d/b-a]
0.5 V	1 MHz	V	W	V	V	± 0.0904 V	V	mV
	10 MHz	V	W	V	V	± 0.0938 V	V	mV
	15 MHz	V	W	V	V	± 0.0956 V	V	mV
	16 MHz	V	W	V	V	± 0.0960 V	V	mV
	50 MHz	V	W	V	V	± 0.1088 V	V	mV
	110 MHz	V	W	V	V	± 0.1313 V	V	mV

OSC Level Accuracy (with 42942A Terminal Adapter)

OSC Level [a]	Freq.	Monitor Reading [b]	Power Meter Reading [c]	Calculated OSC level [d] $= 2\sqrt{50 \times c}$	Monitor Accuracy [b-d]	Monitor Accuracy Limit	OPEN Reading [e]	Test Result [e×d/b-a]
0.5 V	1 MHz	V	W	V	V	± 0.0904 V	V	mV
	10 MHz	V	W	V	V	± 0.0938 V	V	mV
	15 MHz	V	W	V	V	± 0.0956 V	V	mV
	16 MHz	V	W	V	V	± 0.0960 V	V	mV
	50 MHz	V	W	V	V	± 0.1088 V	V	mV
	110 MHz	V	W	V	V	± 0.1313 V	V	mV

DC Bias Monitor Accuracy Test

DC Bias Monitor Accuracy Test (voltage)

Bias Level	Monitor Reading [a]	Multimeter Reading [b]	Test Result [b-a]
0 V	V	V	V
25 V	V	V	V
40 V	V	V	V
-25 V	V	V	V
-40 V	V	V	V

DC Bias Monitor Accuracy

Bias Level [a]	DC Bias Setting 1 [b]	Multimeter Reading 1 [c]	DC Bias Setting 2 [d]=a×b/c	Monitor Reading [e]	Multimeter Reading 2 [f]	Test Result [e-f]
0 mA	0 V	—————	—————	mA	mA	mA
20 mA	0.5 V	mA	V	mA	mA	mA
100 mA	2.5 V	mA	V	mA	mA	mA
-20 mA	-0.5 V	mA	V	mA	mA	mA
-100 mA	-2.5 V	mA	V	mA	mA	mA

DC Bias Level Accuracy Test

DC Bias Level Accuracy Test (voltage)

Bias Level [a]	Multimeter Reading [b]	Test Result Equation [b-a]
0 V	V	V
25 V	V	V
40 V	V	V
-25 V	V	V
-40 V	V	V

DC Bias Level Accuracy Test (current)

Bias Level [a]	Cal Factor ^{*1} [b]	Monitor Reading [c]	Test Result [b×c-a]
0 mA		mA	mA
20 mA		mA	mA
100 mA		mA	mA
-20 mA		mA	mA
-100 mA		mA	mA

*1. Calculate f/e in DC Bias Monitor Accuracy Test Calculation Sheet

Performance Test
Calculation Sheet

Measurement Accuracy Test

Standard Calibration Values (16380A/C,42030A)

Standard	Frequency	Parameter	Calibration Value	Reference Designation
1 pF	1 MHz	Cp	pF	CV1
		D		CV2
	3 MHz	Cp	pF	CV3
		D		CV4
10 pF	1 kHz	Cp	pF	CV5
		D		CV6
	1 MHz	Cp	pF	CV7
		D		CV8
	3 MHz	Cp	pF	CV9
		D		CV10
	10 MHz	Cp	pF	CV11
		D		CV12
100 pF	1 kHz	Cp	pF	CV13
		D		CV14
	1 MHz	Cp	pF	CV15
		D		CV16
	3 MHz	Cp	pF	CV17
		D		CV18
	10 MHz	Cp	pF	CV19
		D		CV20
1000 pF	1 kHz	Cp	pF	CV21
		D		CV22

Standard	Frequency	Parameter	Calibration Value	Reference Designation
0.01 μF	120 Hz	Cp	nF	CV23
		D		CV24
	1 kHz	Cp	nF	CV25
		D		CV26
	10 kHz	Cp	nF	CV27
		D		CV28
0.1 μF	120 Hz	Cp	nF	CV29
		D		CV30
	1 kHz	Cp	nF	CV31
		D		CV32
	10 kHz	Cp	nF	CV33
		D		CV34
1 μF	120 Hz	Cp	μF	CV35
		D		CV36
	1 kHz	Cp	μF	CV37
		D		CV38
10 Ω	DC	R	Ω	CV39
1 Ω	DC	R	Ω	CV40
100 m Ω	DC	R	m Ω	CV41
10 m Ω	DC	R	m Ω	CV42

Performance Test
Calculation Sheet

Standard Calibration Values (16190A)

Table 2-16 Standard Calibration Value

Standard	Frequency	Parameter	Calibration Value	Reference Designation
50 Ω	DC	R	Ω	CV43
	1 MHz	Z	Ω	CV44
		θ	mrad	CV45
	10 MHz	Z	Ω	CV46
		θ	mrad	CV47
	100 MHz	Z	Ω	CV48
		θ	mrad	CV49
Airline with OPEN	1 MHz	Z	Ω	CV50
		θ	rad	CV51
	10 MHz	Z	Ω	CV52
		θ	rad	CV53
	100 MHz	Z	Ω	CV54
		θ	rad	CV55
Airline with SHORT	1 MHz	Z	Ω	CV56
		θ	rad	CV57
	10 MHz	Z	Ω	CV58
		θ	rad	CV59
	100 MHz	Z	Ω	CV60
		θ	rad	CV61

Measurement Accuracy Test

Accessory: Nothing

Standard: 1 pF

OSC Level	Frequency	Parameter	4294A reading [a]	Test Result Equation
0.5 V	1 MHz	Cp	pF	a – CV1
		D		a – CV2
	3 MHz	Cp	pF	a – CV3
		D		a – CV4

Accessory: Nothing

Standard: 10 pF

OSC Level	Frequency	Parameter	4294A reading [a]	Test Result Equation
0.5 V	1 kHz	Cp	pF	a – CV5
		D		a – CV6
	1 MHz	Cp	pF	a – CV7
		D		a – CV8
	3 MHz	Cp	pF	a – CV9
		D		a – CV10
	10 MHz	Cp	pF	a – CV11
		D		a – CV12
0.1 V	1 kHz	Cp	pF	a – CV5
		D		a – CV6

Performance Test
Calculation Sheet

Accessory: Nothing
Standard: 100 pF

OSC Level	Frequency	Parameter	4294A reading [a]	Test Result Equation
0.5 V	1 kHz	Cp	pF	a – CV13
		D		a – CV14
	100 kHz	Cp	pF	a – CV13
		D		a – CV14
	1 MHz	Cp	pF	a – CV15
		D		a – CV16
	3 MHz	Cp	pF	a – CV17
		D		a – CV18
	10 MHz	Cp	pF	a – CV19
		D		a – CV20
0.1 V	1 kHz	Cp	pF	a – CV13
		D		a – CV14
	100 kHz	Cp	pF	a – CV13
		D		a – CV14
	1 MHz	Cp	pF	a – CV15
		D		a – CV16
	3 MHz	Cp	pF	a – CV17
		D		a – CV18
	10 MHz	Cp	pF	a – CV19
		D		a – CV20

Accessory: Nothing
Standard: 1000 pF

OSC Level	Frequency	Parameter	4294A reading [a]	Test Result Equation
0.5 V	1 kHz	Cp	pF	a – CV21
		D		a – CV22
	10 kHz	Cp	pF	a – CV21
		D		a – CV22
	100 kHz	Cp	pF	a – CV21
		D		a – CV22
0.1 V	1 kHz	Cp	pF	a – CV21
		D		a – CV22

Accessory: Nothing
Standard: 0.01 μF

OSC Level	Frequency	Parameter	4294A reading [a]	Test Result Equation
0.5 V	120 Hz	Cp	nF	a – CV23
		D		a – CV24
	1 kHz	Cp	nF	a – CV25
		D		a – CV26
	10 kHz	Cp	nF	a – CV27
		D		a – CV28
0.1 V	1 kHz	Cp	nF	a – CV25
		D		a – CV26

Performance Test
Calculation Sheet

Accessory: Nothing
Standard: 0.1 μ F

OSC Level	Frequency	Parameter	4294A reading [a]	Test Result Equation
0.5 V	120 Hz	Cp	nF	a – CV29
		D		a – CV30
	1 kHz	Cp	nF	a – CV31
		D		a – CV32
	10 kHz	Cp	nF	a – CV33
		D		a – CV34
0.1 V	1 kHz	Cp	nF	a – CV31
		D		a – CV32

Accessory: Nothing
Standard: 1 μ F

OSC Level	Frequency	Parameter	4294A reading [a]	Test Result Equation
0.5 V	120 Hz	Cp	μ F	a – CV35
		D		a – CV36
	1 kHz	Cp	μ F	a – CV37
		D		a – CV38
0.1 V	1 kHz	Cp	μ F	a – CV35
		D		a – CV36

Accessory: Nothing
Standard: 10 Ω

OSC Level	Frequency	Parameter	4294A reading [a]	Test Result Equation
0.5 V	1 kHz	R	Ω	a – CV39
0.1 V	1 kHz	R	Ω	a – CV39

Accessory: Nothing
Standard: 1 Ω

OSC Level	Frequency	Parameter	4294A reading [a]	Test Result Equation
0.5 V	1 kHz	R	Ω	a – CV40
0.1 V	1 kHz	R	Ω	a – CV40

Accessory: Nothing
Standard: 100 m Ω

OSC Level	Frequency	Parameter	4294A reading [a]	Test Result Equation
0.5 V	1 kHz	R	m Ω	a – CV41
0.1 V	1 kHz	R	m Ω	a – CV41

Accessory: Nothing
Standard: 10 m Ω

OSC Level	Frequency	Parameter	4294A reading [a]	Test Result Equation
0.5 V	1 kHz	R	m Ω	a – CV42
0.1 V	1 kHz	R	m Ω	a – CV42

Accessory: 42942A Terminal Adapter
Standard: 50 Ω

OSC Level	Frequency	Parameter	4294A reading [a]	Test Result Equation
0.5 V	1 kHz	Z	Ω	a – CV43
		θ	rad	a
	1 MHz	Z	Ω	a – CV44
		θ	rad	a – CV45
	10 MHz	Z	Ω	a – CV46
		θ	rad	a – CV47
	100 MHz	Z	Ω	a – CV48
		θ	rad	a – CV49

Performance Test
Calculation Sheet

Accessory: 42942A Terminal Adapter
Standard: OPEN

OSC Level	Frequency	Parameter	4294A reading [a]	Test Result Equation
0.5 V	1 MHz	Z	Ω	a – CV50
		θ	rad	a – CV51
	10 MHz	Z	Ω	a – CV52
		θ	rad	a – CV53
	100 MHz	Z	Ω	a – CV54
		θ	rad	a – CV55

Accessory: 42942A Terminal Adapter
Standard: SHORT

OSC Level	Frequency	Parameter	4294A reading [a]	Test Result Equation
0.5 V	1 MHz	Z	Ω	a – CV44
		θ	rad	a – CV45
	10 MHz	Z	Ω	a – CV46
		θ	rad	a – CV47
	100 MHz	Z	Ω	a – CV48
		θ	rad	a – CV49

Accessory: 1m Test Leads
Standard: 10 pF

OSC Level	Frequency	Parameter	4294A reading [a]	Test Result Equation
0.5 V	1 kHz	Cp	pF	a – CV5
		D		a – CV6
	1 MHz	Cp	pF	a – CV7
		D		a – CV8
	3 MHz	Cp	pF	a – CV9
		D		a – CV10
	10 MHz	Cp	pF	a – CV11
		D		a – CV12

Accessory: 1m Test Leads
Standard: 100 pF

OSC Level	Frequency	Parameter	4294A reading [a]	Test Result Equation
0.5 V	1 kHz	Cp	pF	a – CV13
		D		a – CV14
	100 kHz	Cp	pF	a – CV13
		D		a – CV14
	1 MHz	Cp	pF	a – CV15
		D		a – CV16
	3 MHz	Cp	pF	a – CV17
		D		a – CV18
	10 MHz	Cp	pF	a – CV19
		D		a – CV20

Accessory: 1m Test Leads
Standard: 1 Ω

OSC Level	Frequency	Parameter	4294A reading [a]	Test Result Equation
0.5 V	1 kHz	R	Ω	a – CV40

Accessory: 1m Test Leads
Standard: 100 m Ω

OSC Level	Frequency	Parameter	4294A reading [a]	Test Result Equation
0.5 V	1 kHz	R	m Ω	a – CV41

Performance Test
Calculation Sheet

Accessory: 2m Test Leads
Standard: 10 pF

OSC Level	Frequency	Parameter	4294A reading [a]	Test Result Equation
0.5 V	1 kHz	Cp	pF	a – CV5
		D		a – CV6
	1 MHz	Cp	pF	a – CV7
		D		a – CV8
	3 MHz	Cp	pF	a – CV9
		D		a – CV10
	10 MHz	Cp	pF	a – CV11
		D		a – CV12

Accessory: 2m Test Leads
Standard: 100 pF

OSC Level	Frequency	Parameter	4294A reading [a]	Test Result Equation
0.5 V	1 kHz	Cp	pF	a – CV13
		D		a – CV14
	100 kHz	Cp	pF	a – CV13
		D		a – CV14
	1 MHz	Cp	pF	a – CV15
		D		a – CV16
	3 MHz	Cp	pF	a – CV17
		D		a – CV18
	10 MHz	Cp	pF	a – CV19
		D		a – CV20

Accessory: 2m Test Leads
Standard: 1 Ω

OSC Level	Frequency	Parameter	4294A reading [a]	Test Result Equation
0.5 V	1 kHz	R	Ω	a – CV40

Accessory: 2m Test Leads
Standard: 100 mΩ

OSC Level	Frequency	Parameter	4294A reading [a]	Test Result Equation
0.5 V	1 kHz	R	mΩ	a – CV41

2. Performance Test

Performance Test Record

Agilent Technologies 4294A Precision Impedance Analyzer

Serial Number:_____ Options:_____

Temperature:_____°C Date:_____

Humidity:_____ %RH Tested by:_____

Frequency Accuracy Test

Without Option 1D5

Frequency	Test Limit	Test Result	Measurement Uncertainty
10 MHz	±200 Hz	Hz	±2.2 Hz

With Option 1D5

Frequency	Test Limit	Test Result	Measurement Uncertainty
10 MHz	±1.3 Hz	Hz	±0.20 Hz

OSC Level Accuracy Test

OSC Level Accuracy (Accessory: Nothing)

OSC Level	Frequency	Test Limit	Test Result	Measurement Uncertainty
1.0 V	1 kHz	± 101 mV	mV	± 0.2 mV
	100 kHz	± 101 mV	mV	± 0.8 mV
0.5 V	40 Hz	± 51.0 mV	mV	± 0.06 mV
	1 kHz	± 51.0 mV	mV	± 0.09 mV
	10 kHz	± 51.0 mV	mV	± 0.09 mV
	100 kHz	± 51.0 mV	mV	± 0.42 mV
	1 MHz	± 51.3 mV	mV	± 5.2 mV
	10 MHz	± 53.5 mV	mV	± 5.3 mV
	15 MHz	± 54.8 mV	mV	± 5.3 mV
	16 MHz	± 55.0 mV	mV	± 5.3 mV
	50 MHz	± 63.5 mV	mV	± 5.4 mV
	110 MHz	± 78.5 mV	mV	± 5.7 mV
0.25 V	1 kHz	± 26.0 mV	mV	± 0.06 mV
	100 kHz	± 26.0 mV	mV	± 0.22 mV
0.125 V	1 kHz	± 13.5 mV	mV	± 0.04 mV
	100 kHz	± 13.5 mV	mV	± 0.12 mV
0.064 V	1 kHz	± 7.4 mV	mV	± 0.01 mV
	100 kHz	± 7.4 mV	mV	± 0.05 mV
0.016 V	1 kHz	± 2.6 mV	mV	± 0.004 mV
	100 kHz	± 2.6 mV	mV	± 0.02 mV

Performance Test
Performance Test Record

OSC Level Accuracy (with 42942A Terminal Adapter)

OSC Level	Frequency	Test Limit	Test Result	Measurement Uncertainty
0.5 V	1 MHz	± 51.3 mV	mV	± 5.2 mV
	10 MHz	± 53.5 mV	mV	± 5.3 mV
	15 MHz	± 54.8 mV	mV	± 5.3 mV
	16 MHz	± 55.0 mV	mV	± 5.3 mV
	50 MHz	± 63.5 mV	mV	± 5.4 mV
	110 MHz	± 78.5 mV	mV	± 5.7 mV

DC Bias Monitor Accuracy Test

Bias Level	Test Limit	Test Result	Measurement Uncertainty
0 V	± 5.0 mV	mV	± 0.001 mV
25 V	± 55.0 mV	mV	± 0.61 mV
40 V	± 85.0 mV	mV	± 0.86 mV
-25 V	± 55.0 mV	mV	± 0.61 mV
-40 V	± 85.0 mV	mV	± 0.86 mV
0 mA	± 0.50 mA	mA	± 0.001 mA
20 mA	± 0.75 mA	mA	± 0.004 mA
100 mA	± 1.75 mA	mA	± 0.016 mA
-20 mA	± 0.75 mA	mA	± 0.004 mA
-100 mA	± 1.75 mA	mA	± 0.016 mA

DC Bias Level Accuracy Test

Bias Level	Test Limit	Test Result	Measurement Uncertainty
0 V	±5.0 mV	mV	±0.001 mV
25 V	±30.3 mV	mV	±0.61 mV
40 V	±45.6 mV	mV	±0.86 mV
–25 V	±30.3 mV	mV	±0.61 mV
–40 V	±45.6 mV	mV	±0.86 mV
0 mA	±0.20 mA	mA	±0.001 mA
20 mA	±0.60 mA	mA	±0.004 mA
100 mA	±2.20 mA	mA	±0.016 mA
–20 mA	±0.60 mA	mA	±0.004 mA
–100 mA	±2.20 mA	mA	±0.016 mA

2. Performance Test

Performance Test
Performance Test Record

Measurement Accuracy Test

Accessory: Nothing

Standard: 1 pF

OSC Level	Frequency	Parameter	Test Limit	Test Result	Measurement Uncertainty
0.5 V	1 MHz	Cp	±0.0015 pF	pF	±0.0005 pF
		D	±0.0015		±0.0002
	3 MHz	Cp	±0.0057 pF	pF	±0.0010 pF
		D	±0.0057		±0.0008

Accessory: Nothing

Standard: 10 pF

OSC Level	Frequency	Parameter	Test Limit	Test Result	Measurement Uncertainty
0.5 V	1 kHz	Cp	±0.41 pF	pF	±0.0010 pF
		D	±0.041		±0.0001
	1 MHz	Cp	±0.0083 pF	pF	±0.0025 pF
		D	±0.0008		±0.0002
	3 MHz	Cp	±0.033 pF	pF	±0.0030 pF
		D	±0.0033		±0.0005
	10 MHz	Cp	±0.101 pF	pF	±0.015 pF
		D	±0.0101		±0.003
0.1 V	1 kHz	Cp	±2.00 pF	pF	±0.0010 pF
		D	±0.200		±0.0001

Accessory: Nothing
Standard: 100 pF

OSC Level	Frequency	Parameter	Test Limit	Test Result	Measurement Uncertainty
0.5 V	1 kHz	Cp	± 0.47 pF	pF	± 0.010 pF
		D	± 0.0047		± 0.0001
	100 kHz	Cp	± 0.079 pF	pF	± 0.025 pF
		D	± 0.0008		± 0.0002
	1 MHz	Cp	± 0.076 pF	pF	± 0.025 pF
		D	± 0.0008		± 0.0002
	3 MHz	Cp	± 0.30 pF	pF	± 0.030 pF
		D	± 0.0030		± 0.0005
	10 MHz	Cp	± 1.00 pF	pF	± 0.15 pF
		D	± 0.0100		± 0.003
0.1 V	1 kHz	Cp	± 2.07 pF	pF	± 0.010 pF
		D	± 0.0207		± 0.0001
	100 kHz	Cp	± 0.102 pF	pF	± 0.025 pF
		D	± 0.0010		± 0.0002
	1 MHz	Cp	± 0.087 pF	pF	± 0.025 pF
		D	± 0.0009		± 0.0002
	3 MHz	Cp	± 0.32 pF	pF	± 0.030 pF
		D	± 0.0032		± 0.0005
	10 MHz	Cp	± 1.01 pF	pF	± 0.15 pF
		D	± 0.0101		± 0.003

Performance Test
Performance Test Record

Accessory: Nothing
Standard: 1000 pF

OSC Level	Frequency	Parameter	Test Limit	Test Result	Measurement Uncertainty
0.5 V	1 kHz	Cp	± 1.15 pF	pF	± 0.10 pF
		D	± 0.0012		± 0.0001
	10 kHz	Cp	± 0.79 pF	pF	± 0.10 pF
		D	± 0.0008		± 0.0001
	100 kHz	Cp	± 0.76 pF	pF	± 0.10 pF
		D	± 0.0008		± 0.0001
0.1 V	1 kHz	Cp	± 2.8 pF	pF	± 0.10 pF
		D	± 0.0028		± 0.0001

Accessory: Nothing
Standard: 0.01 μ F

OSC Level	Frequency	Parameter	Test Limit	Test Result	Measurement Uncertainty
0.5 V	120 Hz	Cp	± 0.033 nF	nF	± 0.0025 nF
		D	± 0.0033		± 0.0001
	1 kHz	Cp	± 0.0079 nF	nF	± 0.001 nF
		D	± 0.0008		± 0.0001
	10 kHz	Cp	± 0.0076 nF	nF	± 0.0025 nF
		D	± 0.0008		± 0.0002
0.1 V	1 kHz	Cp	± 0.0102 nF	nF	± 0.001 nF
		D	± 0.0010		± 0.0001

Accessory: Nothing
Standard: 0.1 μF

OSC Level	Frequency	Parameter	Test Limit	Test Result	Measurement Uncertainty
0.5 V	120 Hz	Cp	$\pm 0.30 \text{ nF}$	nF	$\pm 0.025 \text{ nF}$
		D	± 0.0030		± 0.0001
	1 kHz	Cp	$\pm 0.076 \text{ nF}$	nF	$\pm 0.01 \text{ nF}$
		D	± 0.0008		± 0.0001
	10 kHz	Cp	$\pm 0.077 \text{ nF}$	nF	$\pm 0.025 \text{ nF}$
		D	± 0.0008		± 0.0002
0.1 V	1 kHz	Cp	$\pm 0.085 \text{ nF}$	nF	$\pm 0.01 \text{ nF}$
		D	± 0.0008		± 0.0001

Accessory: Nothing
Standard: 1 μF

OSC Level	Frequency	Parameter	Test Limit	Test Result	Measurement Uncertainty
0.5 V	120 Hz	Cp	$\pm 0.0030 \mu\text{F}$	μF	$\pm 0.0004 \mu\text{F}$
		D	± 0.0030		± 0.00015
	1 kHz	Cp	$\pm 0.00077 \mu\text{F}$	μF	$\pm 0.0001 \mu\text{F}$
		D	± 0.0008		± 0.0001
0.1 V	1 kHz	Cp	$\pm 0.00085 \mu\text{F}$	μF	$\pm 0.0001 \mu\text{F}$
		D	± 0.0008		± 0.0001

Performance Test
Performance Test Record

Accessory: Nothing
Standard: 10 Ω

OSC Level	Frequency	Parameter	Test Limit	Test Result	Measurement Uncertainty
0.5 V	1 kHz	R	$\pm 0.0100 \Omega$	_____ Ω	$\pm 0.003 \Omega$
0.1 V	1 kHz	R	$\pm 0.0114 \Omega$	_____ Ω	$\pm 0.003 \Omega$

Accessory: Nothing
Standard: 1 Ω

OSC Level	Frequency	Parameter	Test Limit	Test Result	Measurement Uncertainty
0.5 V	1 kHz	R	$\pm 0.0033 \Omega$	_____ Ω	$\pm 0.001 \Omega$
0.1 V	1 kHz	R	$\pm 0.0040 \Omega$	_____ Ω	$\pm 0.001 \Omega$

Accessory: Nothing
Standard: 100 m Ω

OSC Level	Frequency	Parameter	Test Limit	Test Result	Measurement Uncertainty
0.5 V	1 kHz	R	$\pm 2.6 \text{ m}\Omega$	_____ m Ω	$\pm 0.1 \text{ m}\Omega$
0.1 V	1 kHz	R	$\pm 3.2 \text{ m}\Omega$	_____ m Ω	$\pm 0.1 \text{ m}\Omega$

Accessory: Nothing
Standard: 10 m Ω

OSC Level	Frequency	Parameter	Test Limit	Test Result	Measurement Uncertainty
0.5 V	1 kHz	R	$\pm 2.5 \text{ m}\Omega$	_____ m Ω	$\pm 0.01 \text{ m}\Omega$
0.1 V	1 kHz	R	$\pm 3.1 \text{ m}\Omega$	_____ m Ω	$\pm 0.01 \text{ m}\Omega$

Accessory: 42942A Terminal Adapter
Standard: 50 Ω

OSC Level	Frequency	Parameter	Test Limit	Test Result	Measurement Uncertainty
0.5 V	1 kHz	Z	$\pm 0.31 \Omega$	_____ Ω	$\pm 0.090 \Omega$
		θ	$\pm 6.1 \text{ mrad}$	_____ mrad	$\pm 1.8 \text{ mrad}$
	1 MHz	Z	$\pm 0.31 \Omega$	_____ Ω	$\pm 0.090 \Omega$
		θ	$\pm 6.1 \text{ mrad}$	_____ mrad	$\pm 1.8 \text{ mrad}$
	10 MHz	Z	$\pm 0.31 \Omega$	_____ Ω	$\pm 0.090 \Omega$
		θ	$\pm 6.2 \text{ mrad}$	_____ mrad	$\pm 1.8 \text{ mrad}$
	100 MHz	Z	$\pm 0.54 \Omega$	_____ Ω	$\pm 0.010 \Omega$
		θ	$\pm 10.9 \text{ mrad}$	_____ mrad	$\pm 2.0 \text{ mrad}$

Accessory: 42942A Terminal Adapter
Standard: 10 cm Airline with OPEN

OSC Level	Frequency	Parameter	Test Limit	Test Result	Measurement Uncertainty
0.5 V	1 MHz	Z	$\pm 155 \Omega$	_____ Ω	$\pm 44 \Omega$
		θ	$\pm 7.1 \text{ mrad}$	_____ mrad	$\pm 2.0 \text{ mrad}$
	10 MHz	Z	$\pm 15.7 \Omega$	_____ Ω	$\pm 4.4 \Omega$
		θ	$\pm 7.2 \text{ mrad}$	_____ mrad	$\pm 2.0 \text{ mrad}$
	100 MHz	Z	$\pm 2.32 \Omega$	_____ Ω	$\pm 0.43 \Omega$
		θ	$\pm 10.8 \text{ mrad}$	_____ mrad	$\pm 2.0 \text{ mrad}$

Accessory: 42942A Terminal Adapter
Standard: 10 cm Airline with SHORT

OSC Level	Frequency	Parameter	Test Limit	Test Result	Measurement Uncertainty
0.5 V	1 MHz	Z	$\pm 0.0062 \Omega$	_____ Ω	$\pm 0.0017 \Omega$
		θ	$\pm 54.4 \text{ mrad}$	_____ mrad	$\pm 15 \text{ mrad}$
	10 MHz	Z	$\pm 0.0165 \Omega$	_____ Ω	$\pm 0.0043 \Omega$
		θ	$\pm 15.3 \text{ mrad}$	_____ mrad	$\pm 4.0 \text{ mrad}$
	100 MHz	Z	$\pm 0.157 \Omega$	_____ Ω	$\pm 0.027 \Omega$
		θ	$\pm 14.7 \text{ mrad}$	_____ mrad	$\pm 2.5 \text{ mrad}$

Performance Test
Performance Test Record

Accessory: 1m Test Leads
Standard: 10 pF

OSC Level	Frequency	Parameter	Test Limit	Test Result	Measurement Uncertainty
0.5 V	1 kHz	Cp	± 0.41 pF	_____pF	± 0.0010 pF
		D	± 0.041	_____	± 0.0001
	1 MHz	Cp	± 0.013 pF	_____pF	± 0.0025 pF
		D	± 0.0013	_____	± 0.0002
	3 MHz	Cp	± 0.041 pF	_____pF	± 0.0030 pF
		D	± 0.0041	_____	± 0.0005
	10 MHz	Cp	± 0.124 pF	_____pF	± 0.015 pF
		D	± 0.0124	_____	± 0.003

Accessory: 1m Test Leads
Standard: 100 pF

OSC Level	Frequency	Parameter	Test Limit	Test Result	Measurement Uncertainty
0.5 V	1 kHz	Cp	± 0.49 pF	_____pF	± 0.010 pF
		D	± 0.0049	_____	± 0.0001
	100 kHz	Cp	± 0.102 pF	_____pF	± 0.025 pF
		D	± 0.0010	_____	± 0.0002
	1 MHz	Cp	± 0.128 pF	_____pF	± 0.025 pF
		D	± 0.0013	_____	± 0.0002
	3 MHz	Cp	± 0.38 pF	_____pF	± 0.030 pF
		D	± 0.0038	_____	± 0.0005
	10 MHz	Cp	± 1.22 pF	_____pF	± 0.15 pF
		D	± 0.0122	_____	± 0.003

Accessory: 1m Test Leads
Standard: 1 Ω

OSC Level	Frequency	Parameter	Test Limit	Test Result	Measurement Uncertainty
0.5 V	1 kHz	R	$\pm 0.0055 \Omega$	_____ Ω	$\pm 0.001 \Omega$

Accessory: 1m Test Leads
Standard: 100 m Ω

OSC Level	Frequency	Parameter	Test Limit	Test Result	Measurement Uncertainty
0.5 V	1 kHz	R	$\pm 4.6 \text{ m}\Omega$	_____ m Ω	$\pm 0.1 \text{ m}\Omega$

Accessory: 2m Test Leads
Standard: 10 pF

OSC Level	Frequency	Parameter	Test Limit	Test Result	Measurement Uncertainty
0.5 V	1 kHz	Cp	$\pm 0.41 \text{ pF}$	_____ pF	$\pm 0.0010 \text{ pF}$
		D	± 0.041	_____	± 0.0001
	1 MHz	Cp	$\pm 0.015 \text{ pF}$	_____ pF	$\pm 0.0025 \text{ pF}$
		D	± 0.0015	_____	± 0.0002
	3 MHz	Cp	$\pm 0.045 \text{ pF}$	_____ pF	$\pm 0.0030 \text{ pF}$
		D	± 0.0045	_____	± 0.0005
	10 MHz	Cp	$\pm 0.134 \text{ pF}$	_____ pF	$\pm 0.015 \text{ pF}$
		D	± 0.0134	_____	± 0.003

Performance Test
Performance Test Record

Accessory: 2m Test Leads
Standard: 100 pF

OSC Level	Frequency	Parameter	Test Limit	Test Result	Measurement Uncertainty
0.5 V	1 kHz	Cp	± 0.49 pF	_____ pF	± 0.010 pF
		D	± 0.0049	_____	± 0.0001
	100 kHz	Cp	± 0.104 pF	_____ pF	± 0.025 pF
		D	± 0.0010	_____	± 0.0002
	1 MHz	Cp	± 0.128 pF	_____ pF	± 0.025 pF
		D	± 0.0013	_____	± 0.0002
	3 MHz	Cp	± 0.42 pF	_____ pF	± 0.030 pF
		D	± 0.0042	_____	± 0.0005
	10 MHz	Cp	± 1.33 pF	_____ pF	± 0.15 pF
		D	± 0.0133	_____	± 0.003

Accessory: 2m Test Leads
Standard: 1 Ω

OSC Level	Frequency	Parameter	Test Limit	Test Result	Measurement Uncertainty
0.5 V	1 kHz	R	± 0.0055 Ω	_____ Ω	± 0.001 Ω

Accessory: 2m Test Leads
Standard: 100 m Ω

OSC Level	Frequency	Parameter	Test Limit	Test Result	Measurement Uncertainty
0.5 V	1 kHz	R	± 4.6 m Ω	_____ m Ω	± 0.1 m Ω

3 Adjustment

This Chapter describes the Adjustment procedures required to ensure that the 4294A Precision Impedance Analyzer is within its specifications.

Safety Considerations

This manual contains NOTES, CAUTIONs, and WARNINGs that must be followed to ensure the safety of the operator and to keep the instrument in a safe and serviceable condition. The Adjustment must be performed by qualified service personnel.

WARNING

Any interruption of the protective ground conductor (inside or outside the analyzer) or disconnection of the protective ground terminal can make the can make the instrument dangerous. Intentional interruption of the protective ground system for any reason is prohibited.

Required Controller

The following controller system is required to run the adjustment program.

Windows PC	PC-AT Compatible, RAM:≥64MBytes, CPU Pentium 200 MHz or faster
OS	Microsoft® Windows XP®, Windows 2000®
Software	HP VEE (6.1 or 6.2)
GPIB Card	82350, 82340, 82341

Required Equipment

Table 1-1 lists the equipment required to perform the Adjustment procedures described in this chapter. Use only calibrated test equipment when adjusting the 4294A.

Warm-up for Adjustment

Warm-up the analyzer for at least 30 minute before performing any of the following Adjustment procedures to ensure procedures to ensure proper results and correct instrument operation.

Order of Adjustment

When performing more than one Adjustment, perform them in the order they appear in this chapter. The procedures are presented in the following order.

- Write ID

CAUTION

Perform this adjustment only when the EEPROM is replaced. To perform it, select the `WRITE_ID` on the adjustment program.

- Initialize Correction Constant

CAUTION

Perform this adjustment only when the EEPROM is replaced. To perform it, the `Init_CC` on the adjustment program.

- Frequency Accuracy Correction Constants
- Image Rejection Correction Constants
- Lp-Mixer Correction Constants
- Null Offset Correction Constants
- Null Phase Correction Constants
- Relative Impedance Correction Constants
- DC Bias Monitor Correction Constants
- DC Bias Level Correction Constants
- OSC Level Monitor Correction Constants
- OSC Level Correction Constants
- Impedance Measurement Correction Constants
- Frequency Reference Adjustment

Preparation for using the Adjustment Program

To use the Adjustment Program, some preparation is required. This section describes how to its procedure.

Installing an GPIB Card (82340, 82341 or 82350)

Install an GPIB Card into your computer (see the GPIB Card manual). The select code of the GPIB Card should be set to “7”.

Installing HP VEE for Personal Computer

Install the HP VEE into your computer (see the HP VEE for Windows®).

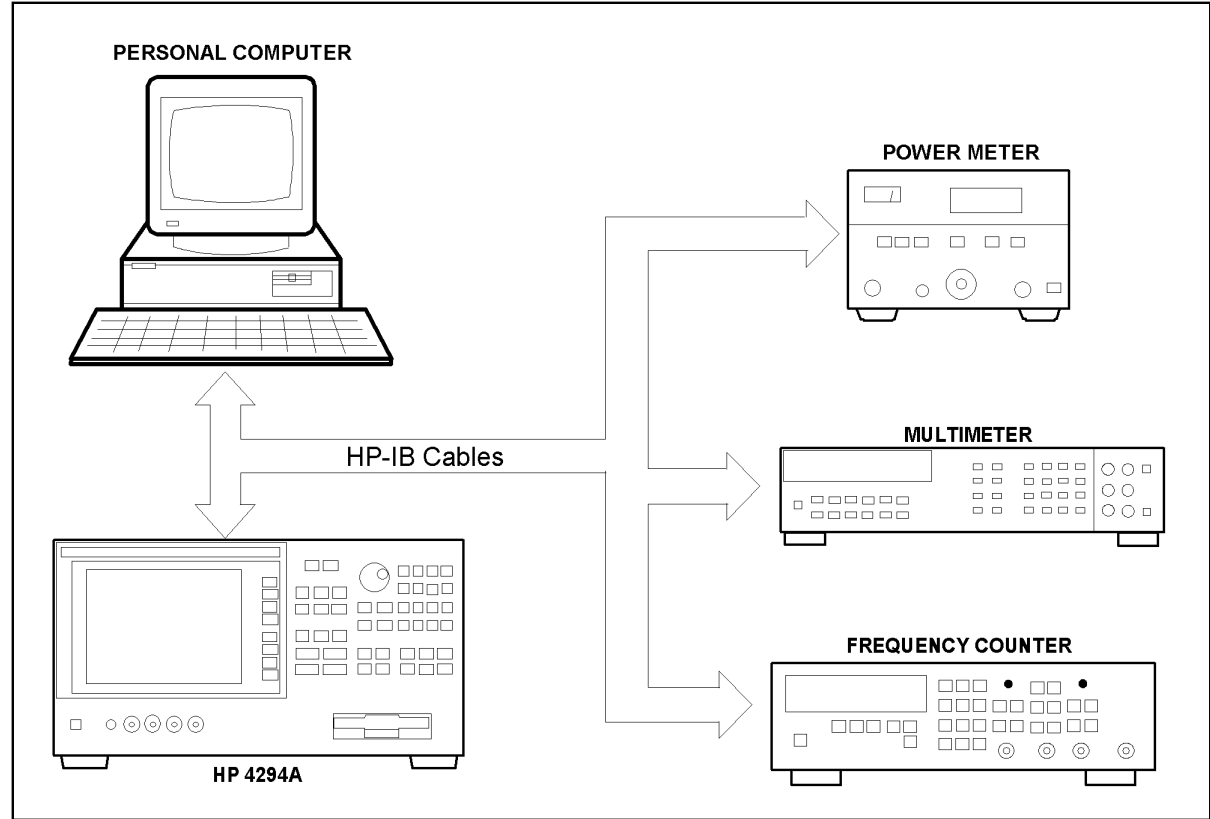
Installing Adjustment Program into Your PC (preliminary)

1. Make a copy of the 4294A adjustment program named `ADJ4294A.EXE` in a directory of your harddisk drive.
2. Double-click the filename on the Windows'Explorer to start extracting the self-extracting archive.
3. You will be prompted to enter directory name for installing the program files. Click `Unzip` to use default directory (`C:\ADJ4294A`).
4. Confirm the message that you successfully extract the files and click `OK` and `Close`.

Equipment Setup

Performing adjustments requires the system described in this section. The Hardware Setup is shown in Figure 3-1.

Figure 3-1 Adjustment Hardware Setup



4294ase03007

Running the Adjustment Program

1. Start the HP VEE.
2. Load the adjustment program file into the HP VEE as follows.
 - a. Pull down the **File** menu from the HP VEE window and select **Open**.
 - b. Select the file **C : \ADJ4294A\ADJ4294A.VEE** and click **Open**.
3. You may be asked to add drivers for the equipment during the program loading. Click **OK** and enter the GPIB address for each equipment. Enter 0 as the address for the equipment which are not used for the adjustment. (Refer to Table 3-1)

Table 3-1

Device Name and GPIB Address Example

Device Name	Equipment	GPIB Address
4294A	4294A	717
P_Meter	Power Meter	713
F_Counter	Frequency Counter	703
3458A	Multimeter	722

4. Click **START** button on the HP VEE Screen.
5. Follow the instruction shown on the display.

The purpose of this procedure is to adjust the signal frequency accuracy.

Required Equipment

Description	Recommended Model
Frequency Counter	53181A or 5334B
BNC(m)-BNC(m) Cable, 61 cm	p/n 04294-61001
Dual Banana-BNC(f) Adapter	p/n 1251-2277

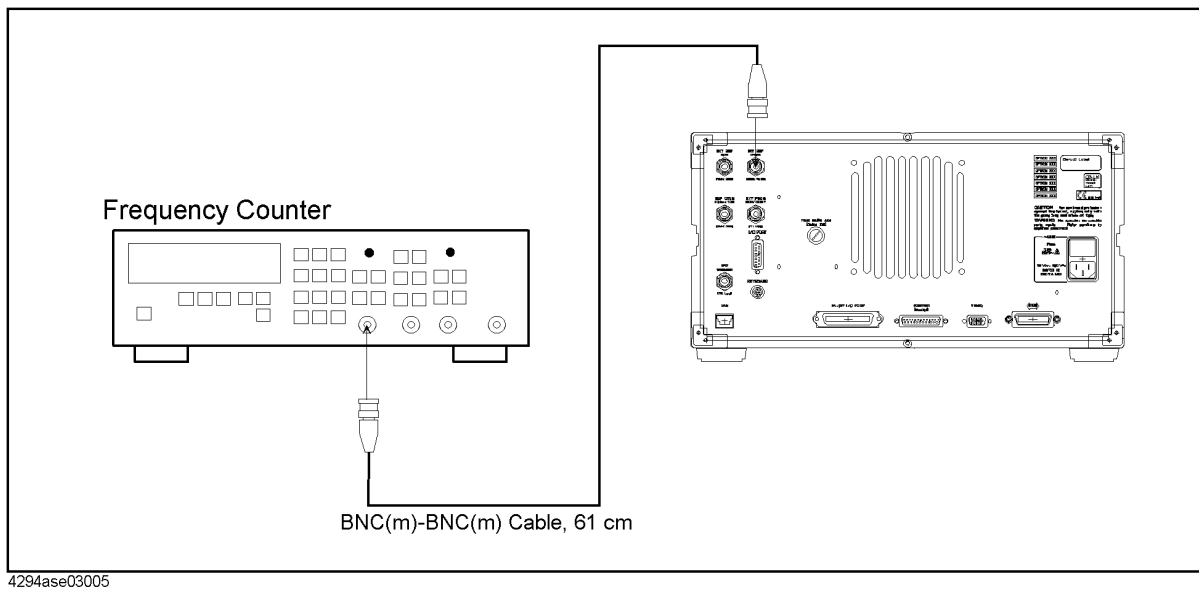
Procedure

1. Run the adjustment program.
2. Choose the Adj_FreqAccy.
3. Connect the equipment as shown in Figure 3-2.

CAUTION

Confirm Nothing is connected to the EXT REF input on the rear panel.

Figure 3-2 Frequency Accuracy Correction Constants Setup



4. Follow the adjustment program instruction to update the correction constants.

Image Rejection Correction Constants

The purpose of this procedure is to generate the correction constants that are used to adjust the Vector Ratio Detector.

Required Equipment

None

Procedure

1. Run the adjustment program.
2. Choose the Adj_ImageRej.
3. Confirm nothing is connected to the 4294A UNKNOWN terminal.
4. Follow the adjustment program instruction to update the correction constants.

LPOT-Mixer Offset Correction Constants

The purpose of this procedure is to adjust the LPOT-Mixer Offset.

Required Equipment

None

Procedure

1. Run the adjustment program.
2. Choose the Adj_LpMix_Leak.
3. Confirm nothing is connected to the 4294A UNKOWN terminal.
4. Follow the adjustment program instruction to update the correction constants.

Null Detector Offset Correction Constants

The purpose of this procedure is to adjust the Null Detector Offset.

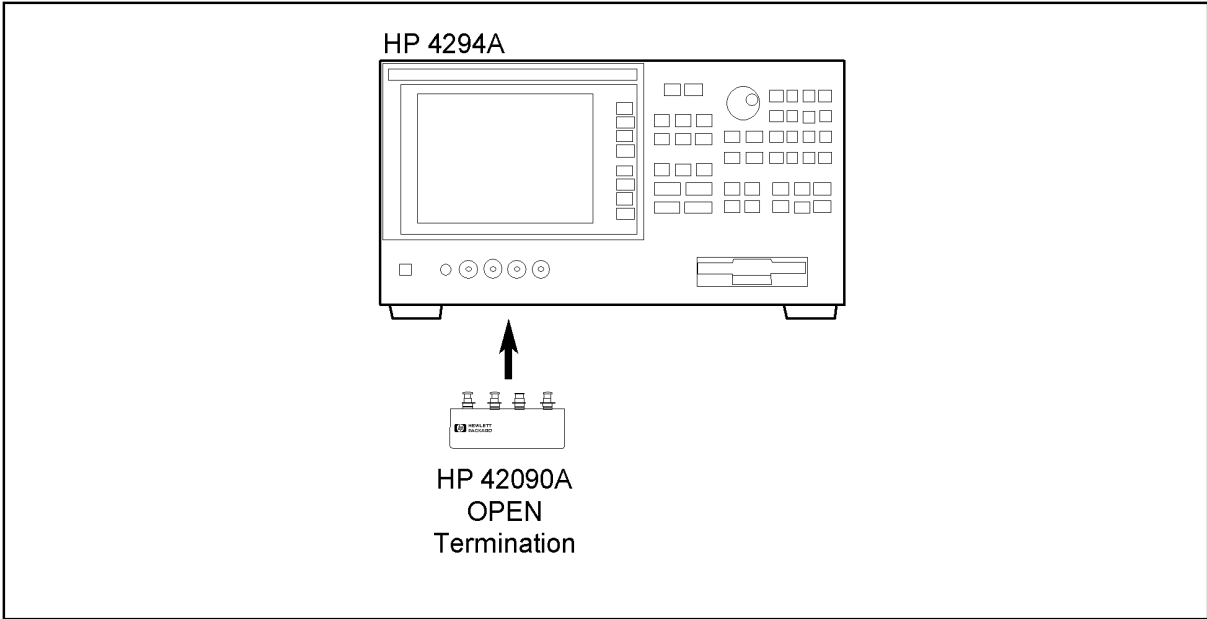
Required Equipment

Description	Recommended Model
4TP OPEN termination	42090A

Procedure

1. Run the adjustment program.
2. Choose the Adj_NullOffset.
3. Connect the OPEN termination as shown in Figure 3-3

Figure 3-3 Null Detector Offset Correction Constants Setup



4294ase03001

4. Follow the adjustment program instruction to update the correction constants.

Null Loop Phase Correction Constants

The purpose of this procedure is to adjust the phase of the null loop.

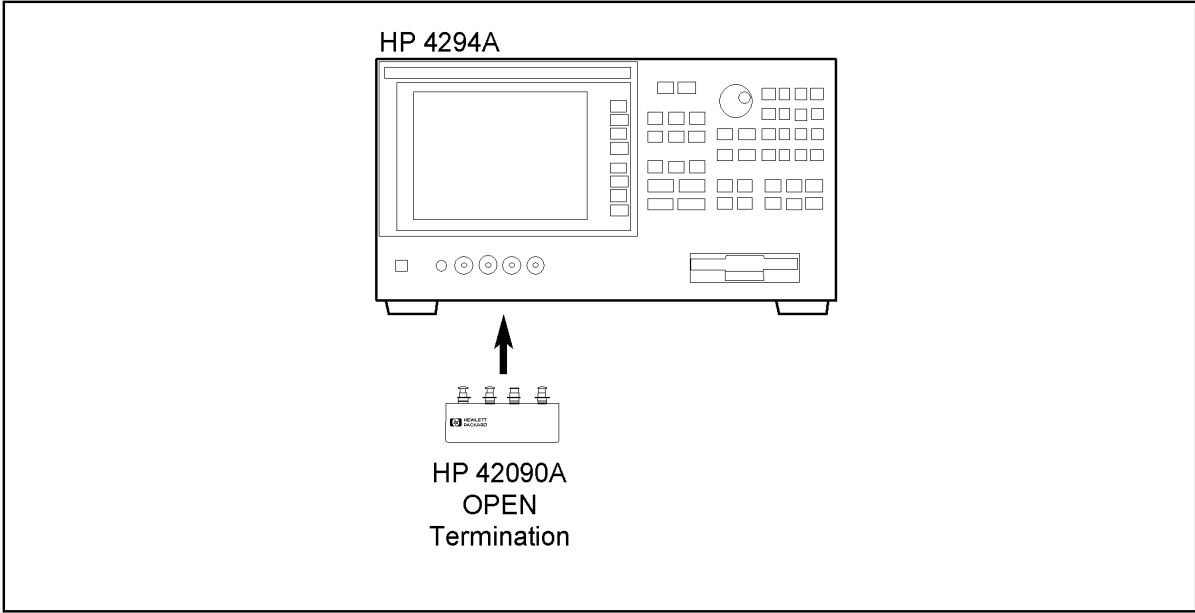
Required Equipment

Description	Recommended Model
4TP OPEN termination	42090A

Procedure

1. Run the adjustment program.
2. Choose the Adj_NullPhase.
3. Connect the OPEN termination as shown in Figure 3-4

Figure 3-4 Null Loop Correction Constants Setup



4294ase03001

4. Follow the adjustment program instruction to update the correction constants.

HPOT-Amplifier Offset Correction Constants

The purpose of this procedure is to adjust the HPOT-amplifier offset.

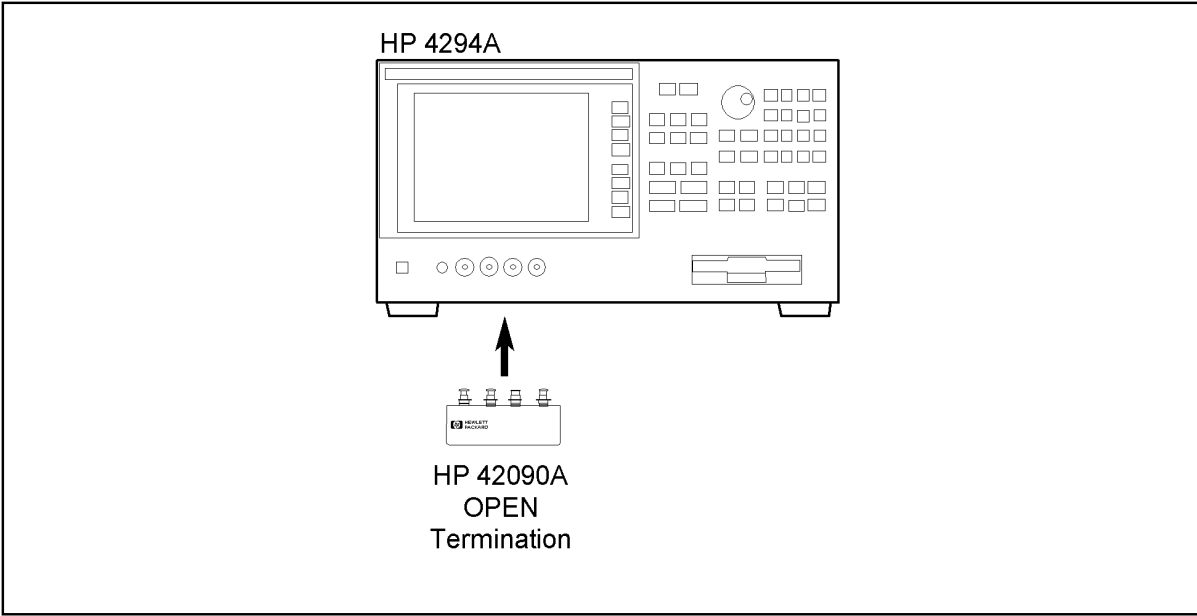
Required Equipment

Description	Recommended Model
4TP OPEN termination	42090A

Procedure

1. Run the adjustment program.
2. Choose the Adj_HpAmp_Ofst.
3. Connect the OPEN termination as shown in Figure 3-6

Figure 3-5 **Relative Impedance Correction Constants Setup**



4294ase03001

4. Follow the adjustment program instruction to update the correction constants.

Relative Impedance Correction Constants

The purpose of this procedure is to adjust the relative impedance between the range resistors.

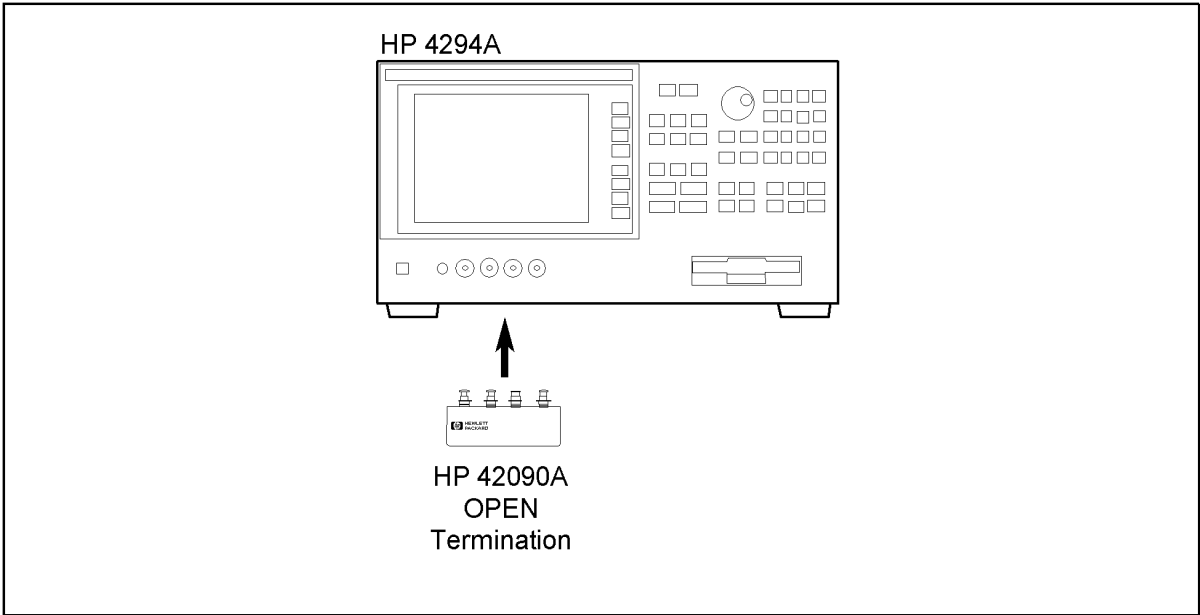
Required Equipment

Description	Recommended Model
4TP OPEN termination	42090A

Procedure

1. Run the adjustment program.
2. Choose the Adj_Relative_Z.
3. Connect the OPEN termination as shown in Figure 3-6

Figure 3-6 Relative Impedance Correction Constants Setup



4294ase03001

4. Follow the adjustment program instruction to update the correction constants.

DC Bias Monitor Correction Constants

The purpose of this procedure is to adjust the DC Bias Monitor.

Required Equipment

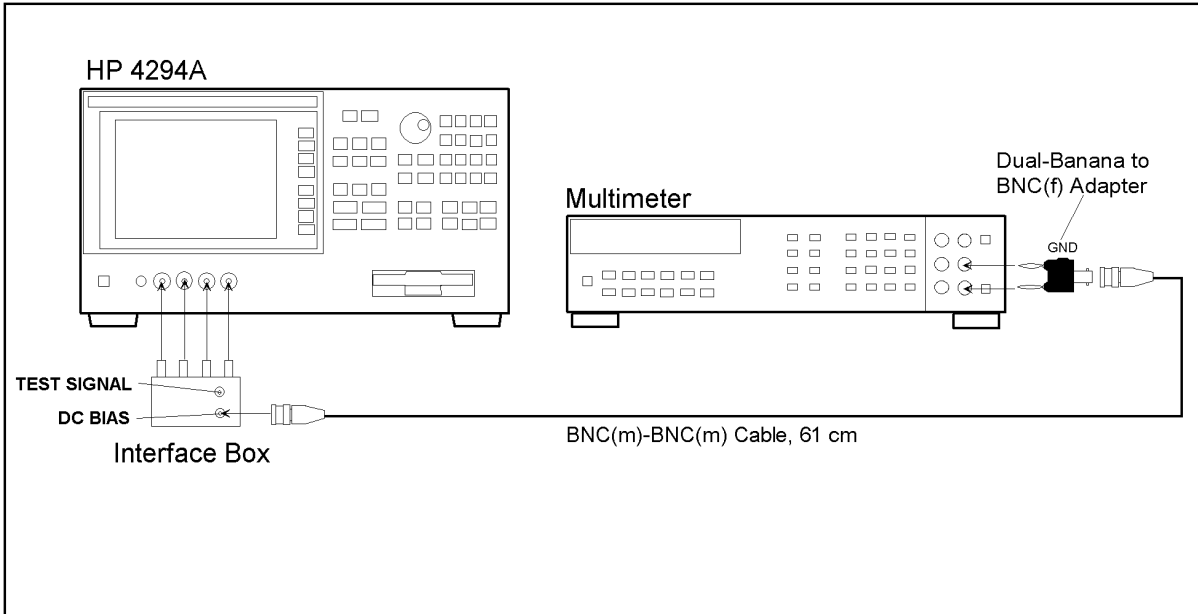
Description	Recommended Model
Multimeter	3458A
Inter face Box	p/n 04294-61002
100 Ω resistor	p/n 04294-61001 ^{*1}
BNC(m)-BNC(m) Cable, 61 cm	p/n 8120-1839
Dual Banana-BNC(f) Adapter	p/n 1251-2277

*1. An attachment to the 4294A

Procedure

1. Run the adjustment program.
2. Choose the Adj_DC_MON.
3. Connect the equipment termination as shown in Figure 3-7.

Figure 3-7 DC Bias Monitor Correction Constants Setup 1

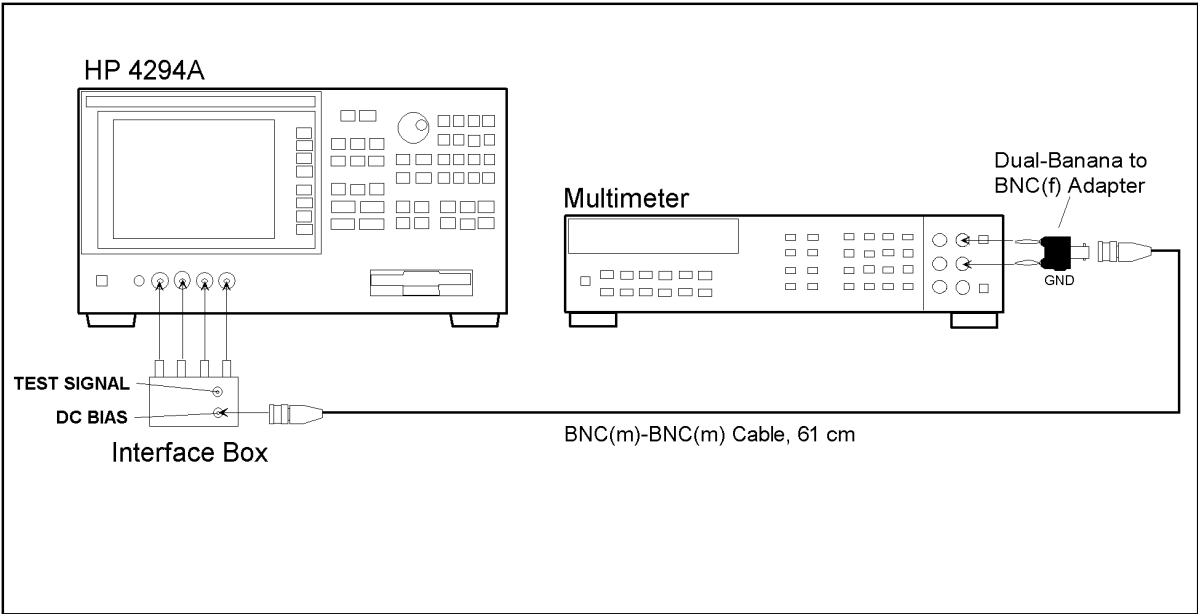


4294ase02005

4. Click OK, then wait till the measurement finish.
5. Disconnect the dual banana plug from the multimeter, then connect it as shown in

Figure 3-8

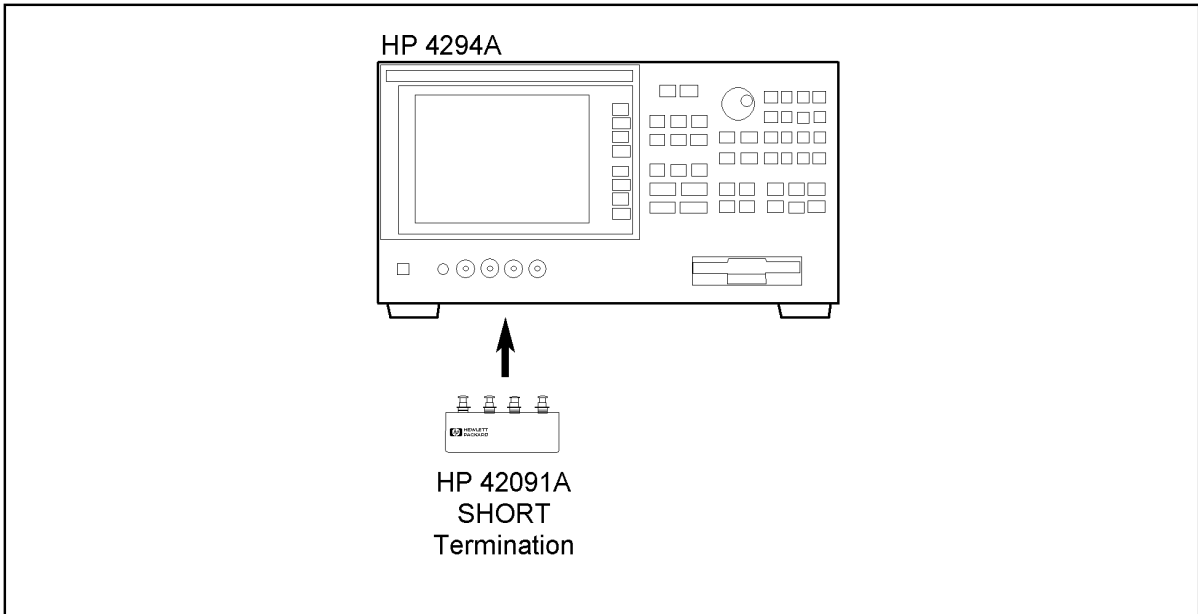
Figure 3-8 DC Bias Monitor Correction Constants Setup 2



4294ase02004

6. Click OK, then wait till the measurement finish.
7. Disconnect the dual banana plug from the multimeter, then connect it as shown in Figure 3-9

Figure 3-9 DC Bias Monitor Correction Constants Setup 3



4294ase03002

8. Follow the adjustment program instruction to update the correction constants.

DC Bias Level Correction Constants

The purpose of this procedure is to adjust the DC bias level.

Required Equipment

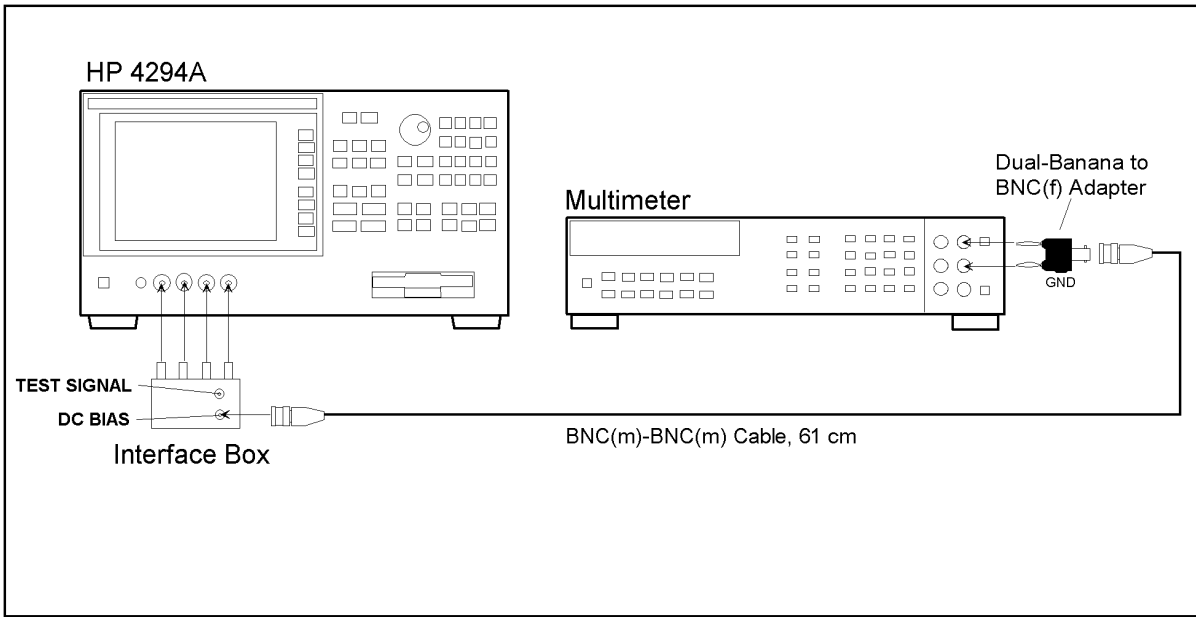
Description	Recommended Model
Multimeter	3458A
Inter face Box	p/n 04294-61002
100 Ω resistor	p/n 04294-61001 ^{*1}
BNC(m)-BNC(m) Cable, 61 cm	p/n 8120-1839
Dual Banana-BNC(f) Adapter	p/n 1251-2277

*1. An attachment to the 4294A

Procedure

1. Run the adjustment program.
2. Choose the Adj_DC_BIAS.
3. Connect the equipment termination as shown in Figure 3-10.

Figure 3-10 DC Bias Level Correction Constants Setup 1



4. Follow the adjustment program instruction to update the correction constants.

OSC Level Monitor Correction Constants

The purpose of this procedure is to adjust the OSC level monitor.

Required Equipment

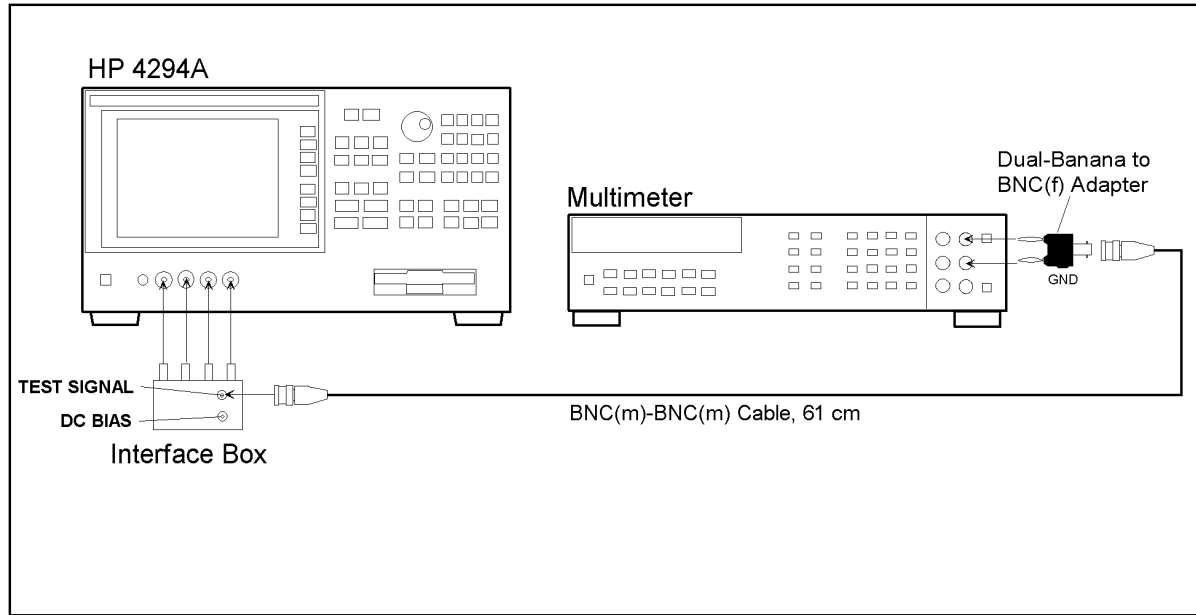
Description	Recommended Model
Multimeter	3458A
Interface Box	p/n 04294-61002
BNC(m)-BNC(m) Cable, 61 cm	p/n 8120-1839
Dual Banana-BNC(f) Adapter	p/n 1251-2277
Power Meter	437B, 438A, E4418A/B, or E4419A/B
Power Sensor	8482A
Power Splitter	11667A
50 Ω termination, N(m)	909C Opt.012

Procedure

1. Run the adjustment program.
2. Choose the Adj_OSC_MON.
3. Connect the equipment as shown in Figure 3-11

Adjustment OSC Level Monitor Correction Constants

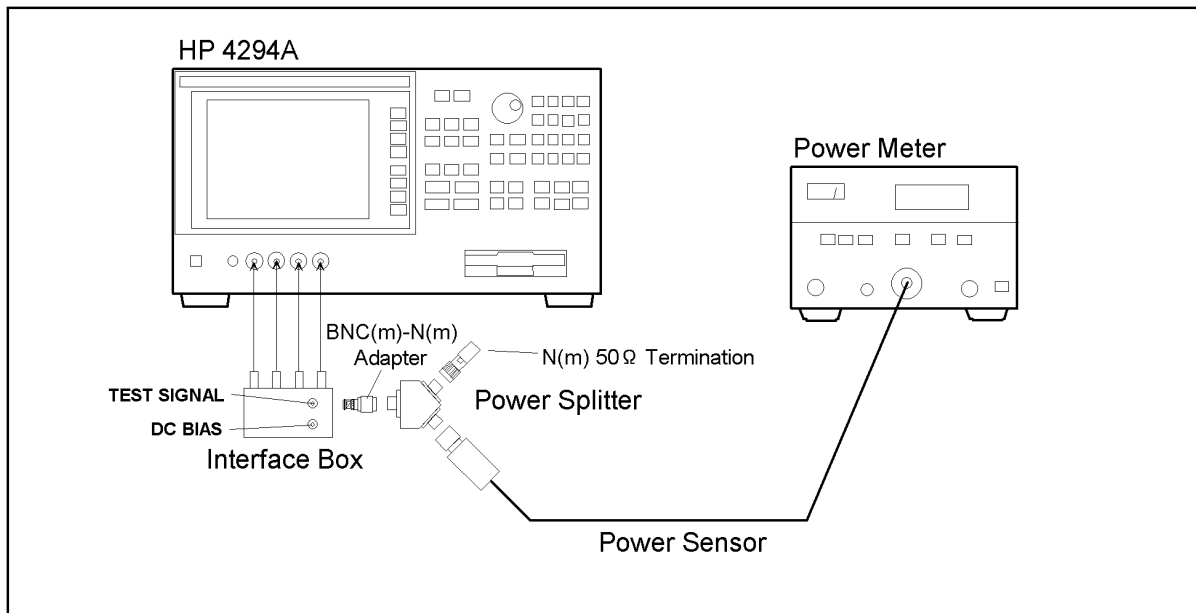
Figure 3-11 OSC Level Monitor Correction Constants Setup 1



4294ase02002

4. Click OK, then wait till the measurement finish.
5. Disconnect equipment from the 4294A, then connect the equipment as shown in Figure 3-12.

Figure 3-12 OSC Level Monitor Correction Constants Setup 2



4294ase02003

6. Follow the adjustment program instruction to update the correction constants.

OSC Level Correction Constants

The purpose of this procedure is to adjust the output oscillation level.

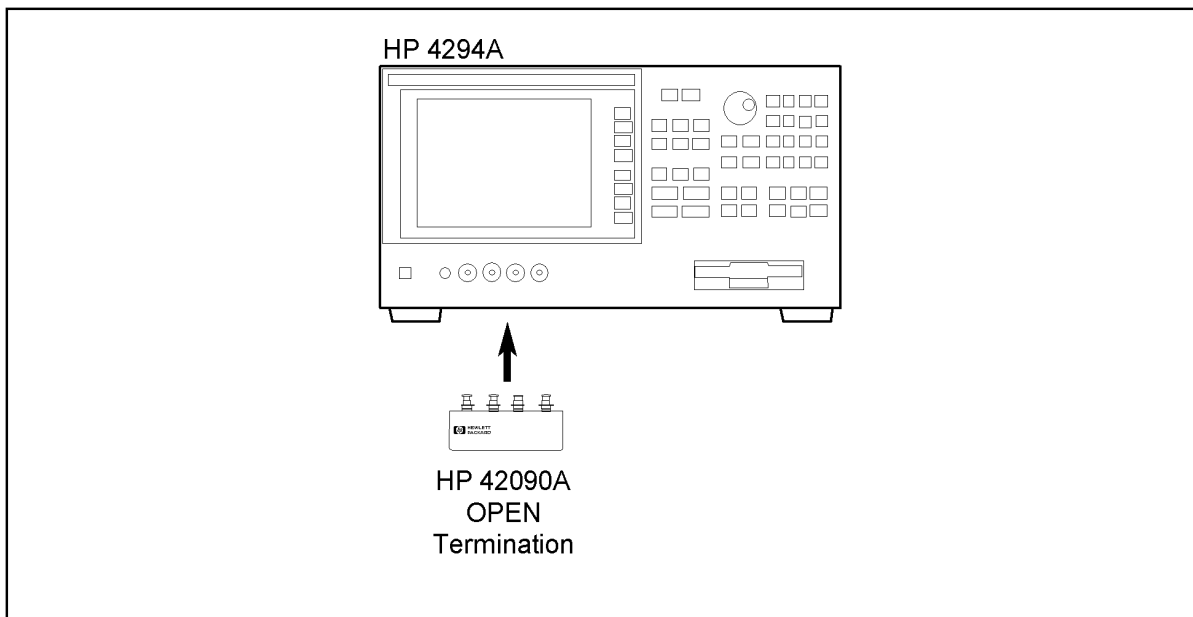
Required Equipment

Description	Recommended Model
4TP OPEN termination	42090A

Procedure

1. Run the adjustment program.
2. Choose the Adj_OSC_LEVEL.
3. Connect the equipment as shown in Figure 3-13

Figure 3-13 OSC Level Correction Constants Setup



4294ase03001

4. Follow the adjustment program instruction to update the correction constants.

Impedance Measurement Correction Constants

The purpose of this procedure is to adjust the relative impedance between the range resistors.

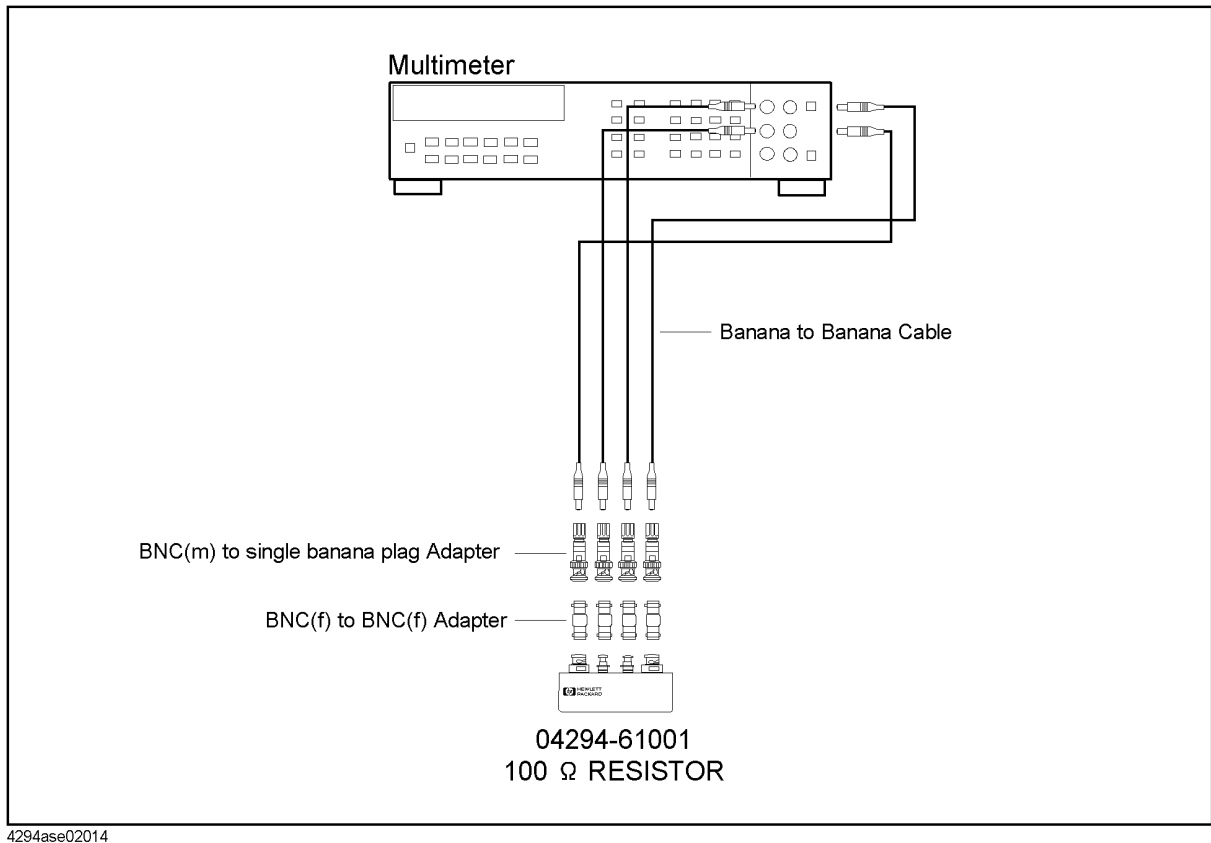
Required Equipment

Description	Recommended Model
Multimeter	3458A
100 Ω resistor	p/n 04294-61001
Banana(m)-Banana(m) Cable	11058A, 2ea
BNC(f)-BNC(f) Adapter	p/n 1250-1830, 4ea
BNC(m)-Banana(f) Adapter	p/n 1250-1263, 4ea

Procedure

1. Run the adjustment program.
2. Choose the Adj_4TP_LOAD.
3. Connect the 100 Ω resistor to the multimeter as shown in Figure 3-14

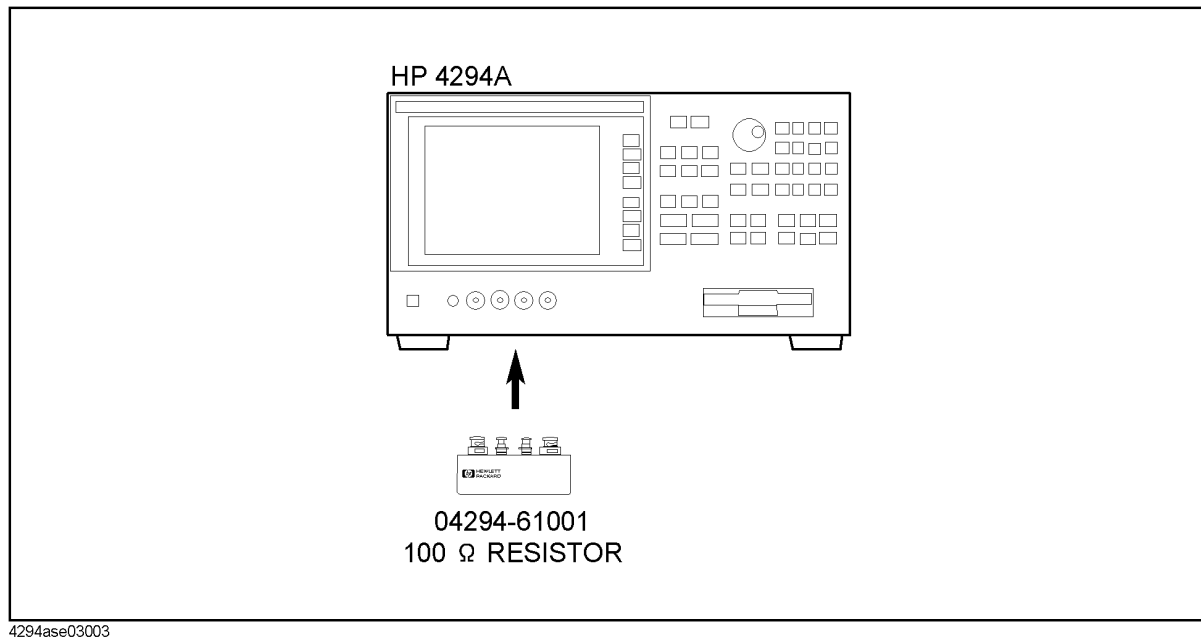
Figure 3-14 Impedance Measurement Correction Constants Setup 1



4. Click OK, then wait till the measurement finish.
5. Connect the 100 Ω Resistor as shown in Figure 3-15.

Adjustment
Impedance Measurement Correction Constants

Figure 3-15 **Impedance Measurement Correction Constants Setup 2**



6. Follow the adjustment program instruction to update the correction constants.

Frequency Reference Adjustment (Opt.1D5 only)

The purpose of this procedure is to adjust the signal frequency accuracy.

NOTE

The adjustment program doesn't include this adjustment. Perform this by manual operation.

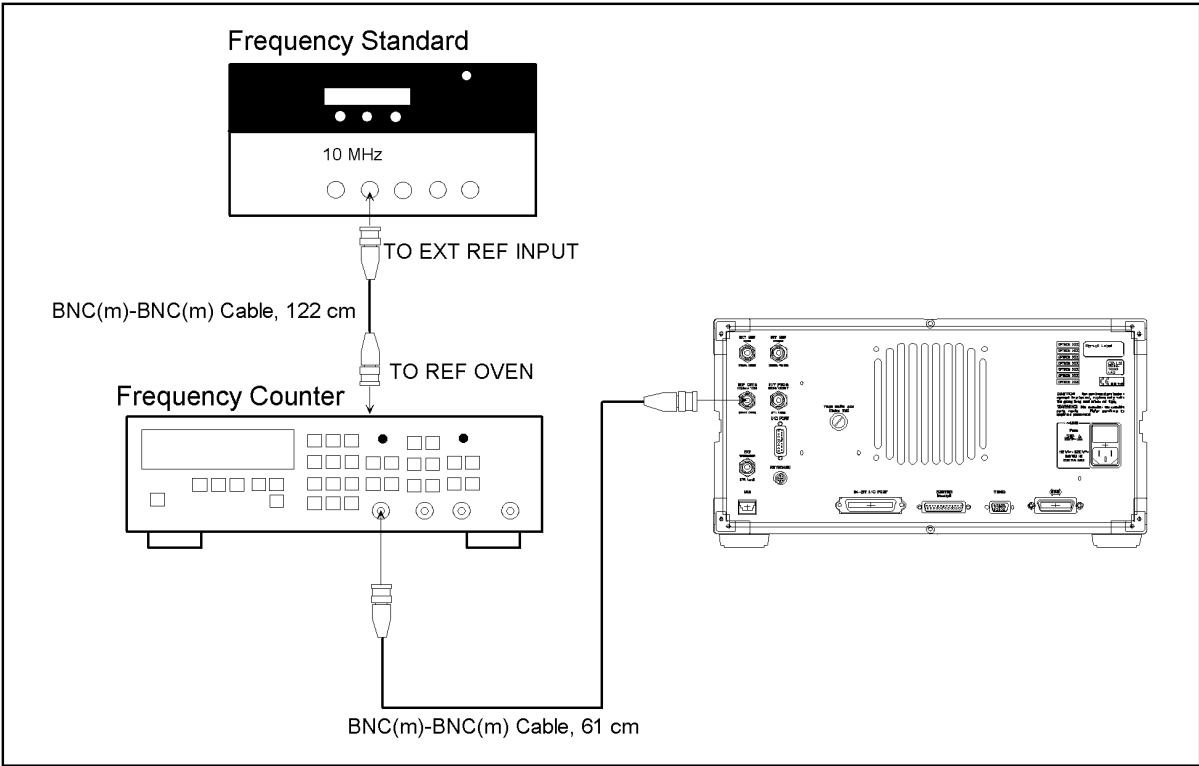
Required Equipment

Description	Recommended Model
Frequency Counter	53181A or 5334B
Frequency Standard	5071A or 5061B
BNC(m)-BNC(m) Cable, 61 cm	p/n 04294-61001
Dual Banana-BNC(f) Adapter	p/n 1251-2277

Procedure

1. Connect the equipment as shown in Figure 3-16

Figure 3-16 Frequency Reference Adjustment Setup



Adjustment

Frequency Reference Adjustment (Opt.1D5 only)

2. Adjust "TIME BASE ADJ" on the rear panel so that the counter reading is $10 \text{ MHz} \pm 0.1 \text{ Hz}$.

4 Troubleshooting

This chapter describes troubleshooting flow and provides the procedure to determine which group or assembly is faulty and should be checked.

TROUBLESHOOTING SUMMARY

The troubleshooting strategy of this manual is based on a verification (rather than symptomatic) approach. This chapter describes typical troubleshooting procedure step by step and you can identify a faulty assembly or a faulty group by following the troubleshooting steps sequentially.

Figure 4-1 diagrams the troubleshooting organization.

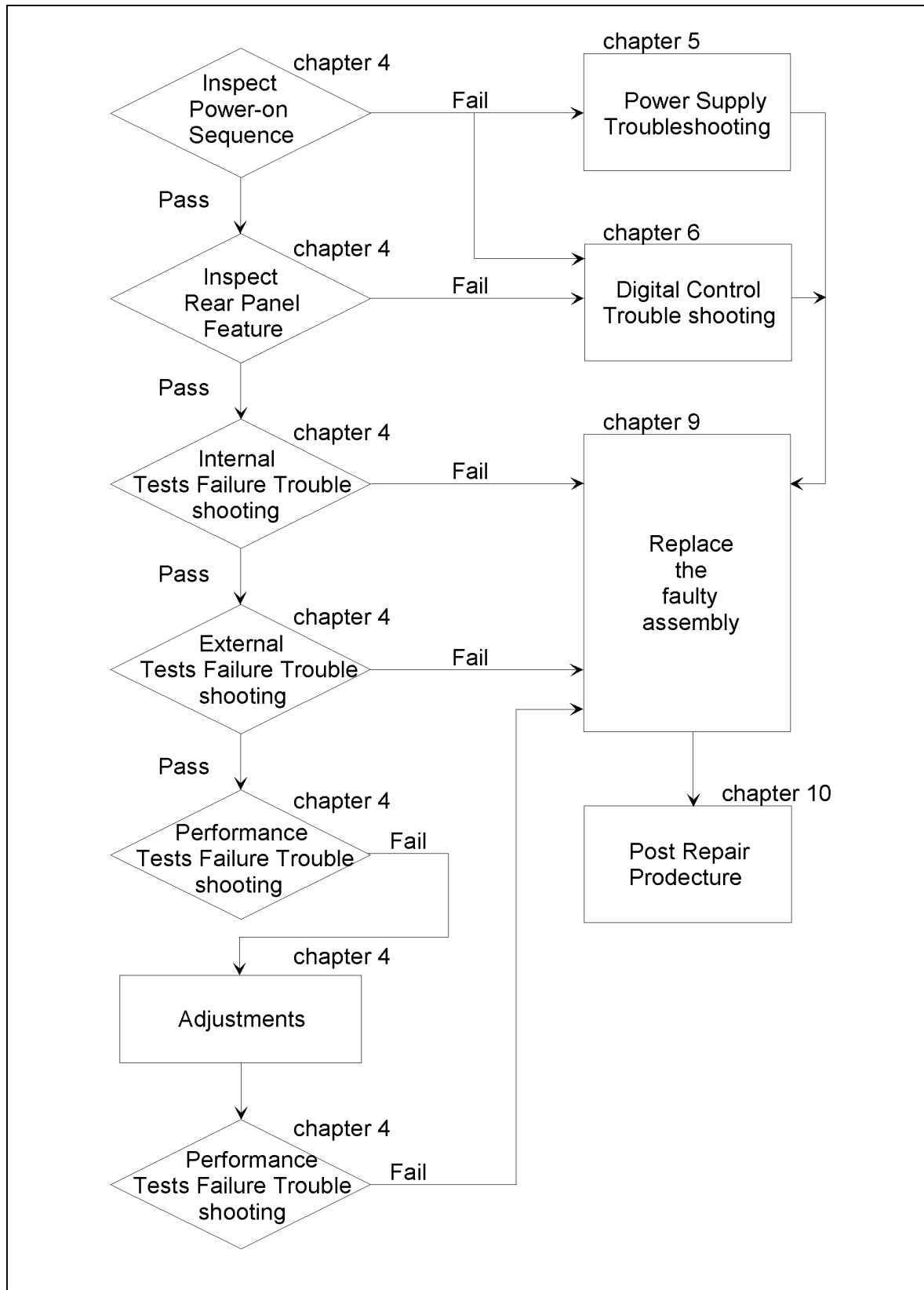
Inspecting the power on sequence and the rear panel feature indicates a faulty group (power supply or digital control). A faulty assembly is isolated to the faulty group according to the troubleshooting procedures for each faulty group. The troubleshooting procedures are given in Chapter 5 and 6.

Performing the internal tests, the external tests or the performance tests indicates a faulty assembly. Assemblies of the analog section (source, transducer and vector ratio detector) of the analyzer are verified by performing these tests.

A faulty assembly is replaced according to Chapter 9. Chapter 9 lists the replaceable parts and gives replacement procedures for the major parts.

The procedures required after assembly replacement, such as adjustments and performance tests, are given in Chapter 10.

Figure 4-1 Troubleshooting Organization



4294ase04001

START HERE

This chapter contains the following troubleshooting procedures. By performing them in the order listed below, you can identify the faulty assembly or the faulty group efficiently.

1. Disconnect everything from the 4294A: All GPIB cable, printer cable, and accessory.
2. Perform the *INSPECT THE POWER-ON SEQUENCE* in this chapter.
3. Perform the *INSPECT THE REAR PANEL FEATURE* in this chapter.
4. Perform the *INTERNAL TESTS FAILURE TROUBLESHOOTING* in this chapter.
5. Perform the *EXTERNAL TESTS FAILURE TROUBLESHOOTING* in this chapter.
6. Perform the performance tests in the *Performance Test* chapter and refer to *PERFORMANCE TEST FAILURE TROUBLESHOOTING* in this chapter.

If the 4294A has passed all of the checks but it still making incorrect measurements or unexpected operations, suspect the accessories. Accessories such as four-terminal-pair test leads and fixtures can all induce system problems.

INSPECT THE POWER ON SEQUENCE

Check the Fan

Turn the analyzer power on. Inspect the fan on the rear panel.

- The fan should be rotating and audible.

If case of unexpected results, check AC line power to the analyzer. Check the fuse (rating listed on the rear panel). Check the line voltage setting. For setting the line voltage, see the *Power Requirements* in Appendix B.

If the problem persists, continue with the *Power Supply Troubleshooting* chapter.

Check the Front Panel LEDs and Displays

Turn on the analyzer and watch for the following events in this order:

1. Three LEDs for **[A]**, **[B]**, and Rmt are lit temporarily. Beep is sounding.
2. The three LEDs turn off. The beep stops.
3. In a minute, the **[A]** LED turns on and the analyzer displays Internal Test In Progress for several seconds.
4. The analyzer displays the graticule.

If case of unexpected results, continue with *Digital Control Troubleshooting* chapter.

Check Error Message

Turn the analyzer power on. Inspect the LCD. No error message should be displayed.

If the following status annotation or error message appears on the LCD, continue with the *INTERNAL TESTS FAILURE TROUBLESHOOTING* in this chapter.

- “Svc” (Status annotation)
- “POWER ON TEST FAILED”

These error messages indicate that one of the power-on self tests fails. If an other error message appears, refer to the *Error Messages* chapter.

If the response of front panel, GPIB commands, or built-in FDD is unexpected, continue with the *Digital Control Troubleshooting* chapter.

INSPECT THE REAR PANEL FEATURE

If the 4294A is operating unexpectedly after these checks are verified, continue with *Digital Control Troubleshooting* chapter.

Check the GPIB Interface

If the unexpected operations appear when controlling the analyzer with an external controller, perform the following checks to verify the problem is not with the controller.

- GPIB interface hardware must be installed in the controller; see the manuals of the controller and the BASIC system.
- I/O and GPIB binaries loaded; see the manuals of the BASIC system.
- Select code; see the manuals of the BASIC system.
- GPIB cables; see the manuals of the BASIC system.
- Programming syntax; see the manuals of the BASIC system.

Check the Parallel Interface

See the *Print the measurement result and internal data using a printer* section at the Chapter 8, *Analysis and Processing of Result*, of the 4294A Operation Manual, and make a hardcopy of the display.

Check the mini DIN Keyboard Connector

See the *Connecting the Supplied Keyboard* at the Chapter 1, *Installation*, of the 4294A Operation Manual.

Internal Tests Failure Troubleshooting

Check the Power-On Selftest

The analyzer performs the power-on selftest every time the analyzer is turned on. In the power-on selftest, internal tests 5 through 16 are executed sequentially. The first failed test indicates the most probable faulty assembly and should be replaced. For more information about the internal tests, see Chapter 7.

If the power-on selftest fails and the “POWER ON TEST FAILED” message is displayed, execute all internal tests to identify the first failed test. Refer to the following steps to execute all internal tests. Then refer to Table 4-1 to know what assembly you should replace.

Execute All Internal Tests

If the power-on self test fails and the “POWER ON TEST FAILED” message is displayed, you should execute the all internal tests and identify the first failed test. To execute all internal tests, you should specify test number as 0 in the HP 4294A diagnostic test mode.

1. Press **[Preset]**, **[System]**, **DIAGNOSTIC TEST**, **[0]**, and **[x1]** to access the internal test 0: ALL INT.
2. Press **RUN TEST** to execute the ALL INT test.
3. Wait until the test result, PASS or FAIL, is displayed.
4. Press the **[↑]**, **[↓]** keys to find the first occurrence of a FAIL message.

Execute the Individual Test

If you would like to perform the internal test individually, you should specify internal test number in the HP 4294A diagnostic test mode.

1. Press **[Preset]**, **[System]**, **DIAGNOSTIC TEST**. Pressing **INTERNAL TEST** jumps to the first test internal test, test:0 ALL INT.
2. Select the test using the RPG knob, **[↑]**, **[↓]** keys or ENTRY keys.
3. Press **RUN TEST** to execute the specified test.
4. Wait until the test result, PASS or FAIL, is displayed.

NOTE Internal tests 1, 2, 3, and 4 are not executed in the power-on selftest. You should perform these tests by specifying test number or by executing all internal tests.

NOTE The troubleshooting procedures requiring the internal tests 1,2, and 4 are also given in Chapter 5.

Table 4-1 Troubleshooting Information for Internal Test Failure

Test No.	First Failed Test	Probable Faulty Assembly										
		A1	A51	A50	A9	A2	A7	A3	A4	A5	A6	A8
1	A1 CPU	†††										
2	A1 VOLATILE MEMORY	†††										
3	A1 FLASH DISK	†††										
4	A51 GSP		†††									
5	ADJUST DATA	†††										
6	BOARD ID	†			†††	†††	†††	†††	†††	†††	†††	†††
7	A8 A/D CONVERTER						††					†††
8	A3 POWER REGULATOR			†				†††				
9	A4 POWER REGULATOR			†					†††			
10	A7 POWER REGULATOR			†			†††					
11	A8 POWER REGULATOR			†								†††
12	A6 IF FREQUENCY						††				†††	
13	A7 IREF D/A						†††					
14	A7 OSCILLATION						†††					
15	A2/A9 AC OSC LEVEL				†††	†††	††					
16	A2/A9 DC BIAS LEVEL				†††	†††						

†††: Most suspicious assembly

††: Suspicious assembly

†: There is some possibility of a fault

External Tests Failure Troubleshooting

If you can't identify the faulty assembly using the internal tests, you can execute the external tests in addition to the internal tests. These external tests are also built-in tests and 9 tests are available in the HP 4294A diagnostic test mode. Refer to Table 4-2 to know which assembly is probably faulty and should be replaced. For more information about the external tests, see Chapter 7.

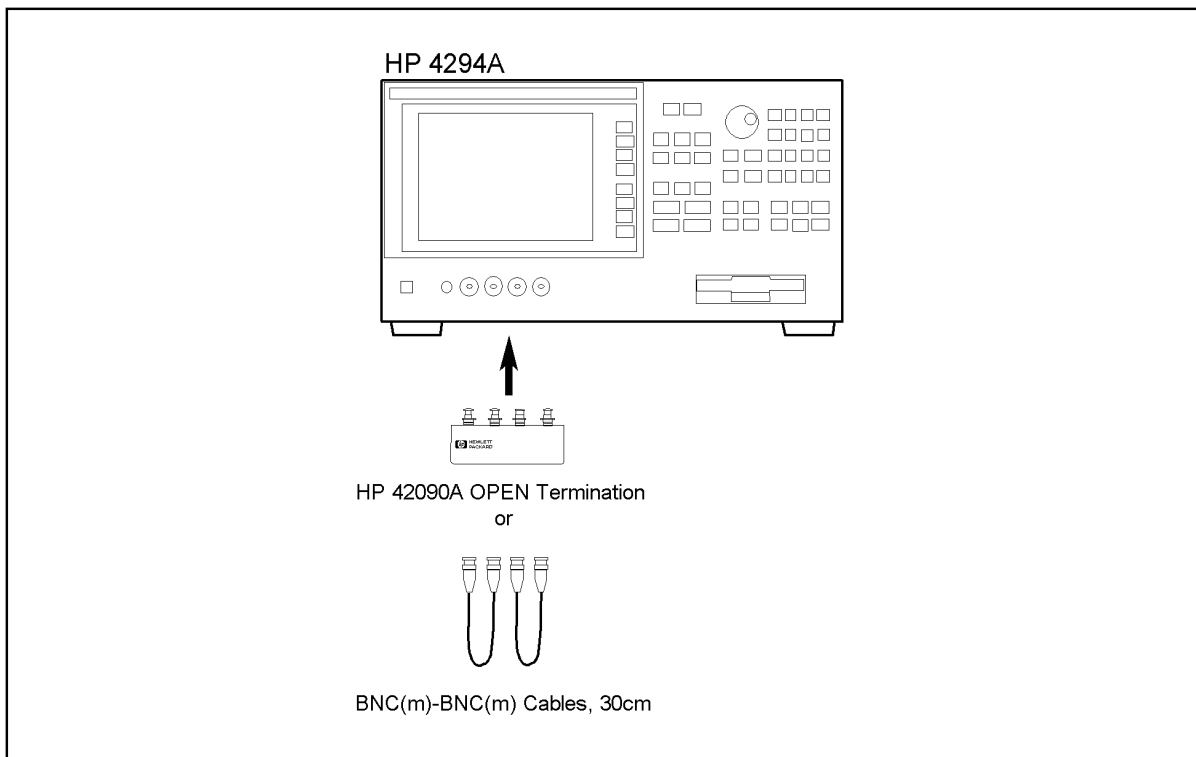
To execute the external tests, perform the following procedures.

1. Press **[Preset]**, **[System]**, **DIAGNOSTIC TEST**. Pressing **EXTERNAL TEST** jumps to the first test external test, test:17 FRONT PANEL.
2. Select the test using the RPG knob, [↑], [↓] keys or ENTRY keys.
3. Press **RUN TEST** to execute the specified test.
4. Wait until the test result, PASS or FAIL, is displayed.

NOTE The troubleshooting procedures requiring the external tests 17,18,and 19 ars also given in Chapter 6.

NOTE The external test 20 consists of the external tests 21 through 26. The external tests 20 through 26 require an OPEN termination (42090A) or two BNC cables to connect Hc and Hp terminals, and Lp and Lc terminals. Refer to Figure 4-2.

Figure 4-2 External Test (20 through 26) Setup



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Table 4-2 Troubleshooting Information for External Test Failure

Test No.	First Failed Test	Probable Faulty Assembly										
		A1	A51	A30	A53	A2	A7	A3	A4	A5	A6	A8
17	FRONT PANEL	†		†††								
18	FLOPPY DISK DRIVE	†			†††							
19	24bit IO		†††									
20	ALL ANALOG*1											
21	A8 IF											†††
22	A3 VCH and A8 FRONTEND							†††				††
23	A2 ATT					†††						
24	A5 NULL FRONTEND									†††		
25	A4/5/6 NULL								††		††	
26	A3 ICH and A4							††	††			

*1. It consists of the external tests 21 through 26.

†††: Most suspicious assembly

††: Suspicious assembly

†: There is some possibility of a fault

Performance Tests Failure Troubleshooting

Perform the following procedure sequentially when any performance tests fail.

Perform Adjustments and Correction Constants

Table 4-3 gives the recommended adjustments and correction constants when a performance test fails. If a performance test fails, you should perform the corresponding adjustments or correction constants function as shown in Table 4-3. If the tests still fail, refer to Table 4-4 and replace the assembly.

Note that this table lists some typical cases. In a few cases, other assembly may actually be faulty.

Table 4-3 Troubleshooting Information for Performance Test Failure 1

Test No.	First Failed Test	Adjustment												
		Frequency Accuracy CC	Image Rejection CC	Lpot-Mixer Offset CC	Null Detector Offset CC	Null Loop Phase CC	Hpot-Amplifier Offset CC	Relative Impedance CC	DC Bias Monitor CC	DC Bias Level CC	OSC Level Monitor CC	OSC Level CC	Impedance Measurement CC	Oven Reference Adj (Opt. 1D5)
1	Frequency Accuracy Test (Std)	√												
	Frequency Accuracy Test (opt. 1D5)													√
2	OSC Level Accuracy Test										√	√		
3	DC Bias Monitor Accuracy Test								√					
4	DC Bias Level accuracy Test									√				
5	Measurement accuracy test		√		√	√		√					√	

Table 4-4 Troubleshooting Information for Performance Test Failure 2

Test No.	First Failed Test	Probable Faulty Assembly										
		A1	A51	A50	A9	A2	A7	A3	A4	A5	A6	A8
1	Frequency Accuracy Test						†††					
2	OSC Level Accuracy Test				††	†††	††					
3	DC Bias Monitor Accuracy Test				††	†††						
4	DC Bias Level Accuracy Test				††	†††						
5	Measurement Accuracy Test						†	†††	†††	†††	†††	†††

†††: Most suspicious assembly

††: Suspicious assembly

†: There is some possibility of a fault

5

Power Supply Troubleshooting

This chapter describes troubleshooting procedures to isolate the faulty assembly within the power supply functional group.

INTRODUCTION

Use this procedure only if you have read *Troubleshooting*, and you believe the problem is in the power supply. The procedure is designed to let you identify the bad assembly within the power supply functional group in the shortest possible time.

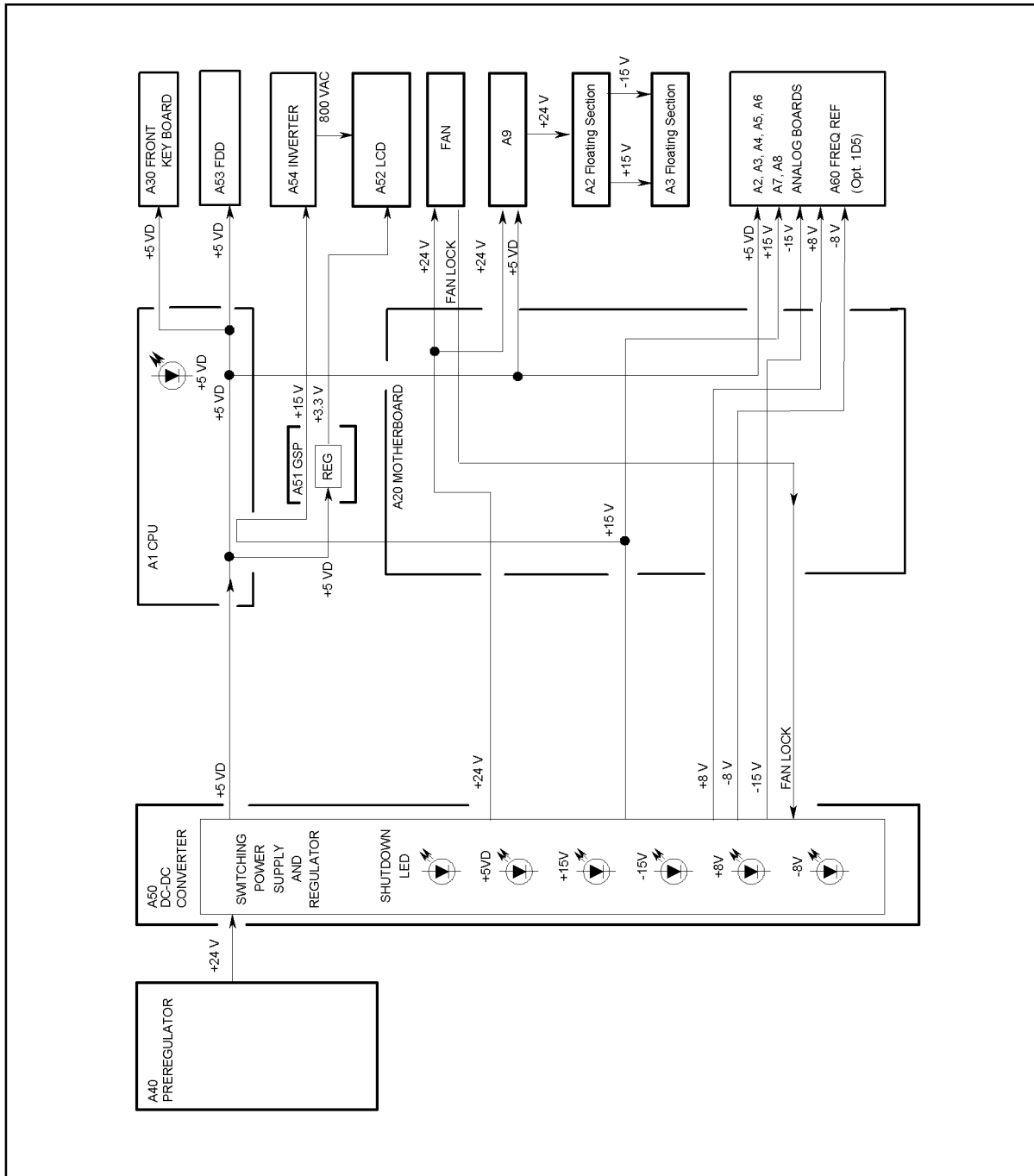
The power supply functional group consists of:

- A40 Pre-Regulator
- A50 DC-DC Converter
- A9 Floating Power Supply

All assemblies, however, are related to the power supply functional group because power is supplied to each assembly. Figure 5-1 shows all power lines in simplified block diagram form.

If an assembly is replaced, see *Post Repair Procedures* in the *Post Repair Procedures* chapter in this manual. It tells what additional tests or adjustments need to be done after replacing any assembly.

Figure 5-1 Power Supply Lines Simplified Block Diagram



4294ase05001

START HERE

1. Check the Fan

Look at the fan on the rear panel. Check that the fan is rotating.

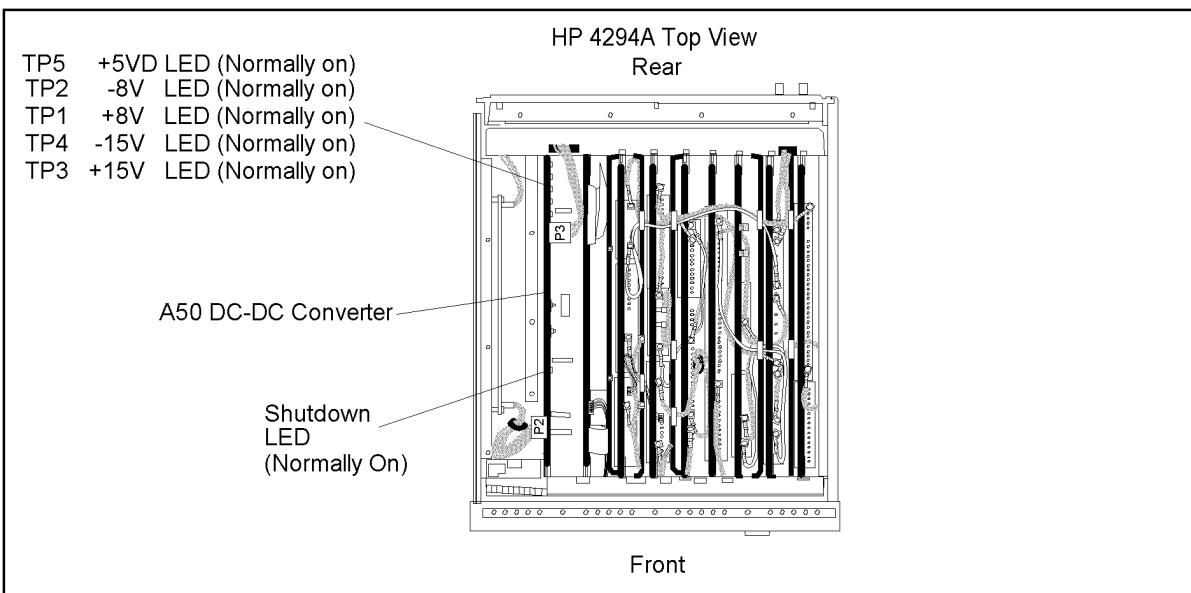
- If the fan is not rotating, continue with the *FIND OUT WHY THE FAN IS NOT ROTATING* section in this chapter.
- If the fan is rotating, continue with *Check the A50 SHUTDOWN LED*.

2. Check the A50 SHUTDOWN LED

There is a LED, SHUTDOWN LED, on the A50 DC-DC Converter. Perform the following procedure to check it. The SHUTDOWN LED is described in the next A50 SHUTDOWN LED.

1. Turn the analyzer power off.
 2. Remove the analyzer's top cover and shield plate.
 3. Turn the analyzer power on.
 4. Look at the A50 SHUTDOWN LED. The LED is normally on. The SHUTDOWN LED location on A50 DC-DC Converter is shown in Figure 5-2.
- If the A50 SHUTDOWN LED is off, continue with the *FIND OUT WHY THE A50 SHUTDOWN LED IS OFF* section in this chapter.
 - If the A50 SHUTDOWN LED is on, continue with *Check the A50 Five LEDs*.

Figure 5-2 A50 SHUTDOWN LED and Five LEDs Location



4294ase05002

A50 Shutdown LED

The A50 SHUTDOWN LED turning off indicates some of A50 power supply is shut down by the A50 shutdown circuitry.

There are two FAN conditions, rotating and not rotating when the SHUTDOWN LED turns off. When the fan is rotating, the shutdown circuit is probably activated by the over current condition on the power lines in the A50 DC-DC Converter. In this condition, though the A50 power supplies, +5 VD, +15 V, -15 V, +8 V, and -8 V are shut down, the Fan Power +24 V is still supplied to the fan. When the fan is not rotating, the shutdown circuit is probably activated by the FAN LOCK signal missing.

NOTE

Once the A50 shutdown circuit is activated, the only way to reset the circuit is by turning the analyzer power off. Wait a minute after turning the analyzer off. Then turn it on.

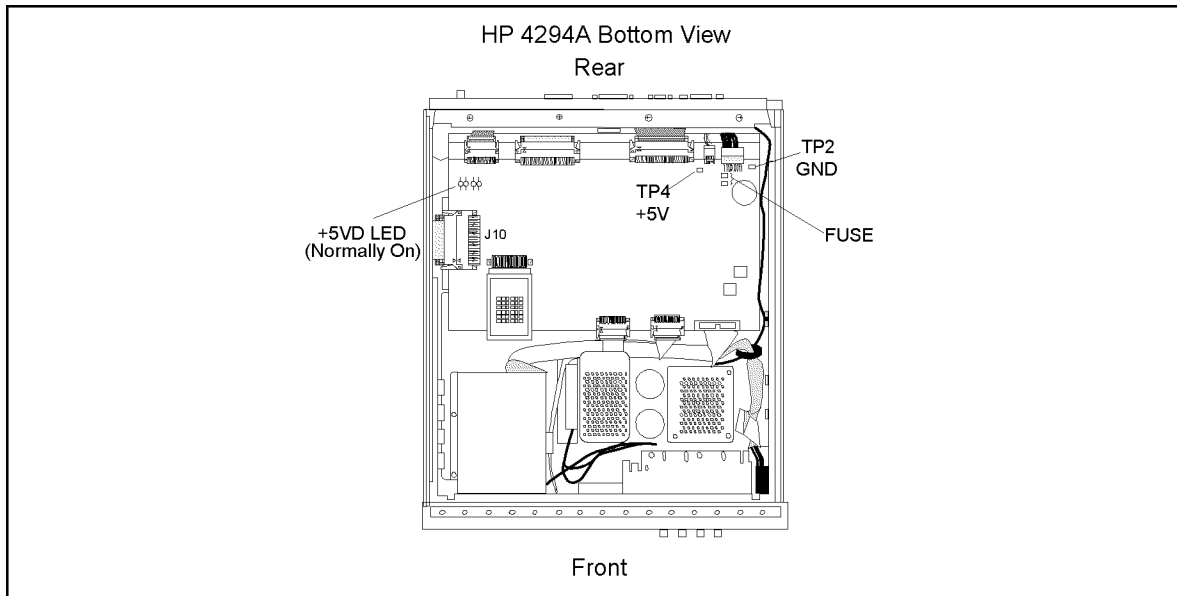
3. Check the A50 Five LEDs

1. Turn the analyzer power on.
2. Look at the A50 Five LEDs. The LEDs are normally on. The Five LEDs locations on the A50 DC-DC Converter is shown in Figure 5-2.
 - If one or more LEDs are off, continue with the *Troubleshoot the A50 DC-DC Converter* section in this chapter.
 - If the A50 Five LEDs are correctly on, continue with the next step, *Check the A1 +5 VD LED*.

4. Check the A1 +5 VD LED

1. Remove the analyzer's bottom cover.
2. Turn the analyzer power on.
3. Look at the +5 VD LED. The +5 VD LED location on A1 CPU is shown in Figure 5-3. The LED is normally on.
 - If the +5 VD LED is off, continue with the *FIND OUT WHY THE A1 +5 VD LED IS NOT ON STEADILY* section in this chapter.
 - If the +5 VD LED is on, the +5 VD power supply is verified with 95% confidence level. If you want to confirm the last 5% uncertainty, perform steps in the next step, *Measure the A1 +5 VD Voltage*.

Figure 5-3 A1 +5 VD LED Location



4294ase05003

Measure the A1 +5 VD Voltage

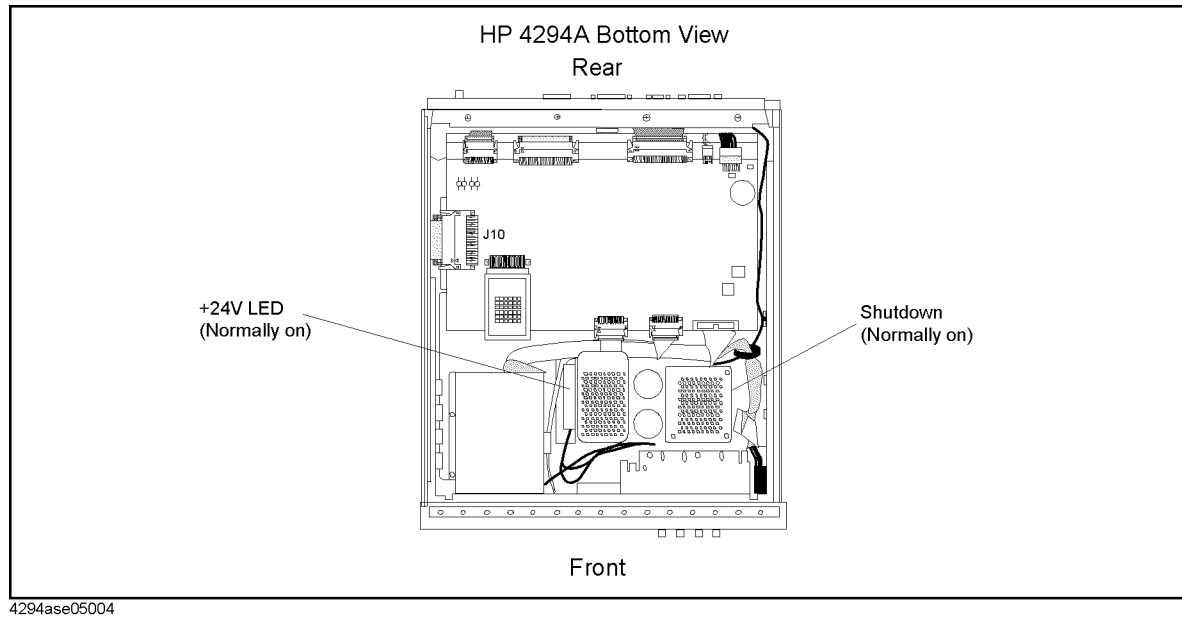
Measure the DC voltage on a test point A1TP4 (+5 V) using a voltmeter. Check that the voltmeter reading is within 4.6 V to 5.4 V.

- If the voltmeter reading is not within these limits, continue with the *FIND OUT WHY THE A1 LED IS NOT ON STEADILY* section.
- If the voltmeter reading is within these limits, the +5 VD power supply is verified.

5. Check the A9 Two LEDs

1. Remove the analyzer's bottom cover.
2. Turn the analyzer power on.
3. Look at the Two LEDs. The LED's location on A9 Floating Power Supply is shown in Figure 5-4. The LEDs are normally on.
 - If the A9 Two LEDs are on, the A9 is verified.
 - If one or two LEDs are off, continue with the next step, *Disconnect Wire from A3 P11*.

Figure 5-4 **A9 Two LEDs Location**



Disconnect Wire from A3 P11

Turn the analyzer power off. Disconnect the wire from the A3 P11 and turn the analyzer power on. The A3 P11 location is shown in Figure 5-5.

- If the one or two LEDs are still off, continue with the next step, *Disconnect RF cable “M” from A2*.
- If the two LEDs go on, replace the A3 assembly.

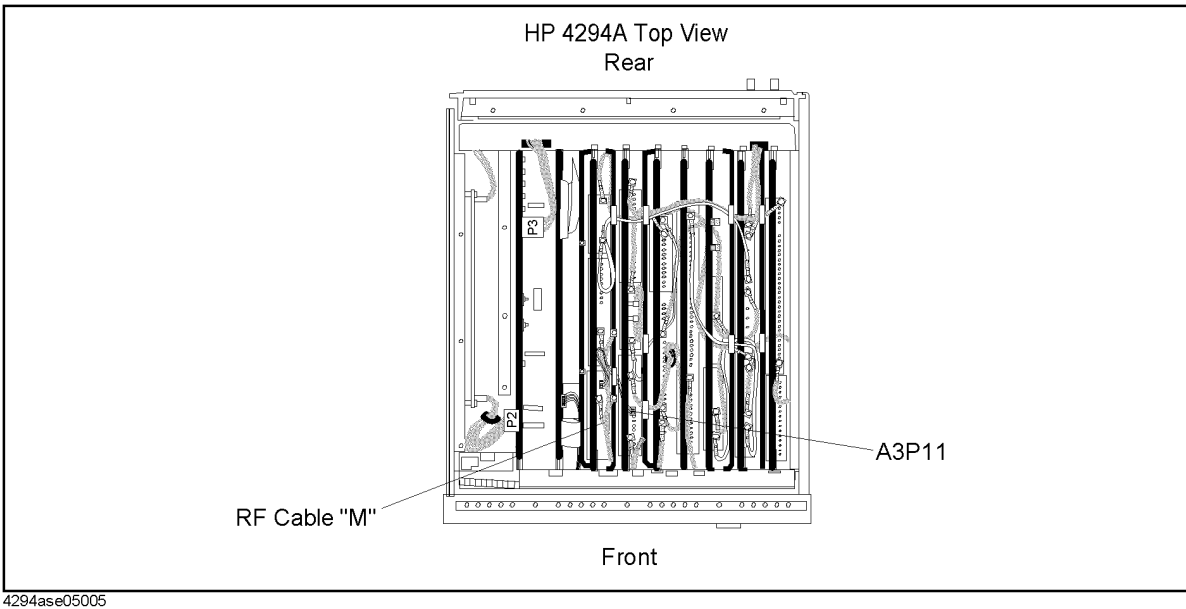
Disconnect RF cable “M” from A2 Hc Amp assembly

Turn the analyzer power off. Disconnect the cable “M” from the A2 Hc Amp assembly and turn the analyzer power on. The RF cable “M” location is shown in Figure 5-5.

- If the one or two LEDs are still off, replace the A9 assembly.
- If the two LEDs go on, replace the A2 Hc Amp assembly.

Power Supply Troubleshooting
START HERE

Figure 5-5 A3 P11 and RF Cable “M” location



FIND OUT WHY THE FAN IS NOT ROTATING

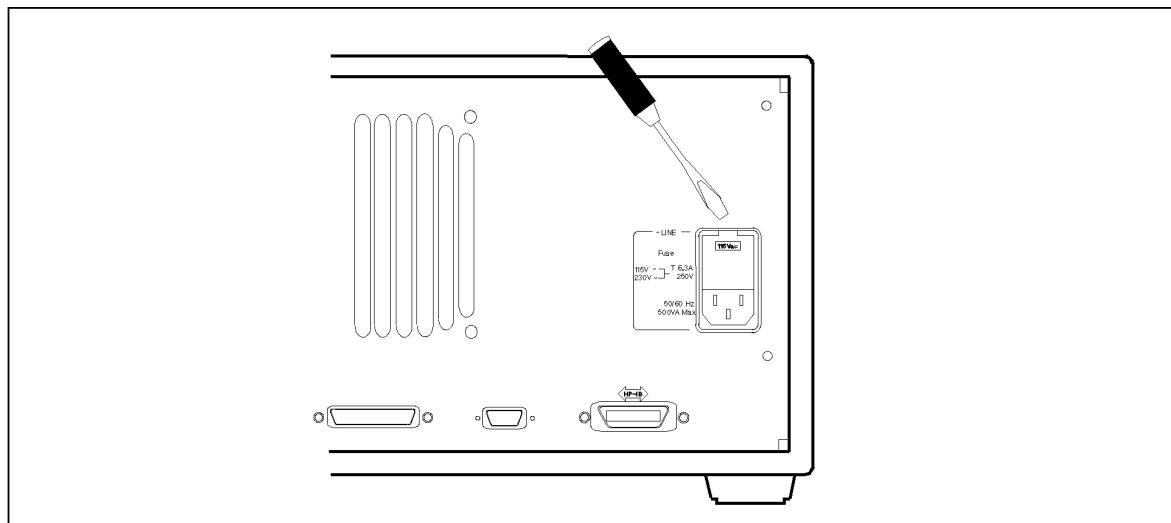
If the fan is not rotating, the problem may be in the A40 pre-regulator, the A50 DC-DC Converter or the fan.

1. Check the Line Voltage, Selector Switch Setting, and Fuse

Check the main power line cord, line fuse, and actual line voltage to see that they are all correct. Figure 5-6 shows how to remove the line fuse, using a small flat-bladed screwdriver to pry off the fuse holder. For more information about the line cord and line fuse, see the *Power Requirements* in Appendix C.

Figure 5-6

Removing Line Fuse

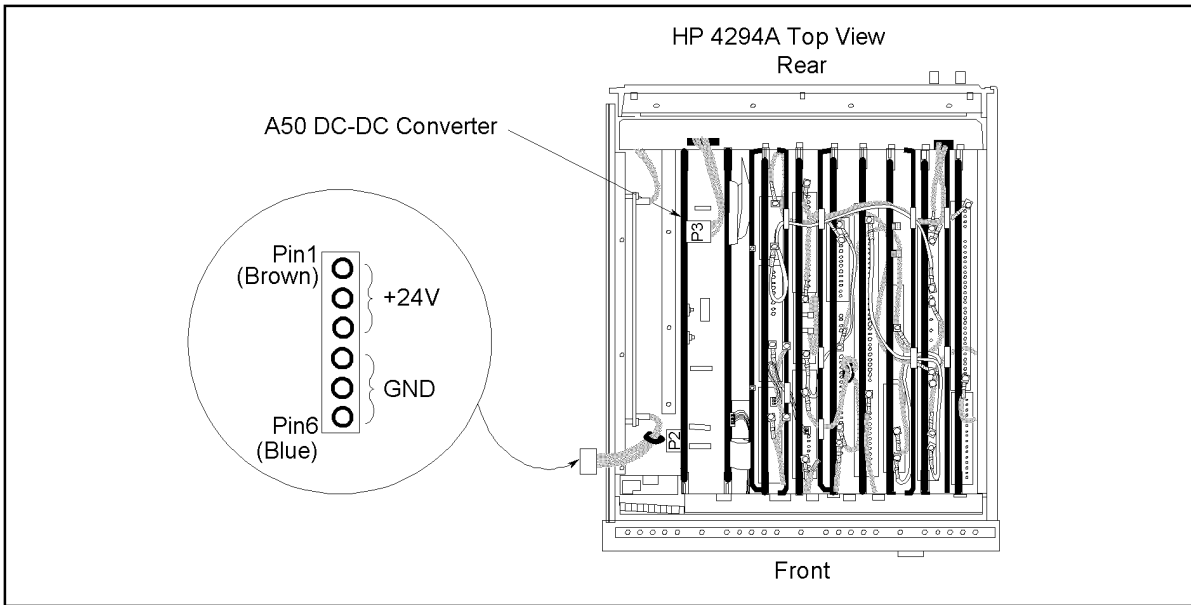


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2. Check the A40 Pre-Regulator

1. Turn the analyzer power off.
2. Disconnect the cable from the A50S2. The A50S2 location is shown in Figure 5-7.
3. Turn the analyzer power on.
4. Check the voltage between pin 1 and pin 6(GND) of the cable within +22.0 V to +27.0 V using a voltmeter with a small probe.
 - If the voltmeter reading is not within these limits, replace the A40 pre-regulator.
 - If the voltmeter reading is within these limits, the A40 pre-regulator is verified. Turn the analyzer power off and reconnect the cable to the A50S2. Then continue with *Check the A50 SHUTDOWN LED*.

Figure 5-7 **A40 Output Voltage**



3. Check the A50 SHUTDOWN LED

When the fan stops, the A50 SHUTDOWN LED is off. The fan generates a FAN LOCK signal. The signal is fed into the FAN LOCK SENSE circuit in the A50 DC-DC converter. If the FAN stops, the FAN LOCK signal is missing. Then the FAN LOCK SENSE circuit activates the A50 shutdown circuitry, resulting the SHUTDOWN LED being turned off.

Perform the following procedure to check that the A50 SHUTDOWN LED is on.

1. Turn the analyzer power on.
2. Look at the A50 SHUTDOWN LED. The LED location is shown in Figure 5-2.
 - If the SHUTDOWN LED is on, replace the A50 DC-DC Converter.
 - If the SHUTDOWN LED is off, continue with the *TROUBLESHOOT THE FAN AND THE A50 DC-DC Converter* section in this chapter.

FIND OUT WHY THE A50 SHUTDOWN LED IS OFF

Use this procedure when the fan is rotating. If the fan is not rotating, see *FIND OUT WHY THE FAN IS NOT ROTATING*.

If the fan is rotating and the A50 SHUTDOWN LED is off, the problem may be in the A50 DC-DC Converter and any of assemblies obtaining the power from +5 VD supply and the higher power supplies.

1. Disconnect the Cable from the A50P3

Turn the analyzer power off. Disconnect the cable from A50P3. Turn the analyzer power on.

- If the A50 SHUTDOWN LED goes on, continue with *FIND OUT WHY THE A1 +5VD LED IS NOT ON STEADILY*.
- If the A50 SHUTDOWN LED is still off, the A1 CPU is verified. Turn the analyzer power off and reconnect the cable to the A50P3. Continue with *Remove A50*.

2. Remove A50

1. Turn the analyzer power off.
2. Remove the A50 from the A20 motherboard. The cable from the A50P2 and the cable from the A50P3 are connected.
3. Turn the analyzer power on.
 - If the A50 SHUTDOWN LED is still off, replace the A50 DC-DC Converter.
 - If the A50 SHUTDOWN LED goes on and Five LEDs go on, the A50 is verified. Reinstall the A50. Continue with the next step.

3. Remove Assemblies

1. Turn the analyzer power off.
2. Remove the assemblies A2, A3, A4, A5, A6, A7, and A8.
3. Turn the analyzer power on.
 - If the A50 SHUTDOWN LED is still off, inspect the A20 motherboard for soldering bridges and shorted traces on the FAN POWER and the FAN LOCK signal paths.
 - If the A50 SHUTDOWN LED goes on, the A20 motherboard is verified. Continue with the next step.
4. Reinstall each assembly one at a time. Turn the analyzer power on after each is installed. The assembly that causes the A50 SHUTDOWN LED to go off is the most probable faulty assembly. Replace the assembly.

FIND OUT WHY THE A1 +5 VD LED IS NOT ON STEADILY

If the +5 VD LED is not on steadily, the +5 VD line voltage is missing or is not enough to power the analyzer. The problem may be in the A50 DC-DC Converter, the A1 CPU, and any of assemblies obtaining the power from +5 VD supply.

1. Check the A50 DC-DC Converter

1. Turn the analyzer power off. Disconnect the cable from A50P3. Turn the analyzer power on.
2. Look at the A50 +5 VD LED. The LED is normally on.
3. Check that the voltage between the TP5 and GND is within +4.8 V to +5.4 V using a voltmeter with a small probe.
 - If the voltmeter reading is not within these limits, replace the A50 DC-DC Converter.
 - If the voltmeter reading is within these limits, the A50 +5 VD power supply is verified. Then continue with the *Measure the A1 +5V Voltage*.

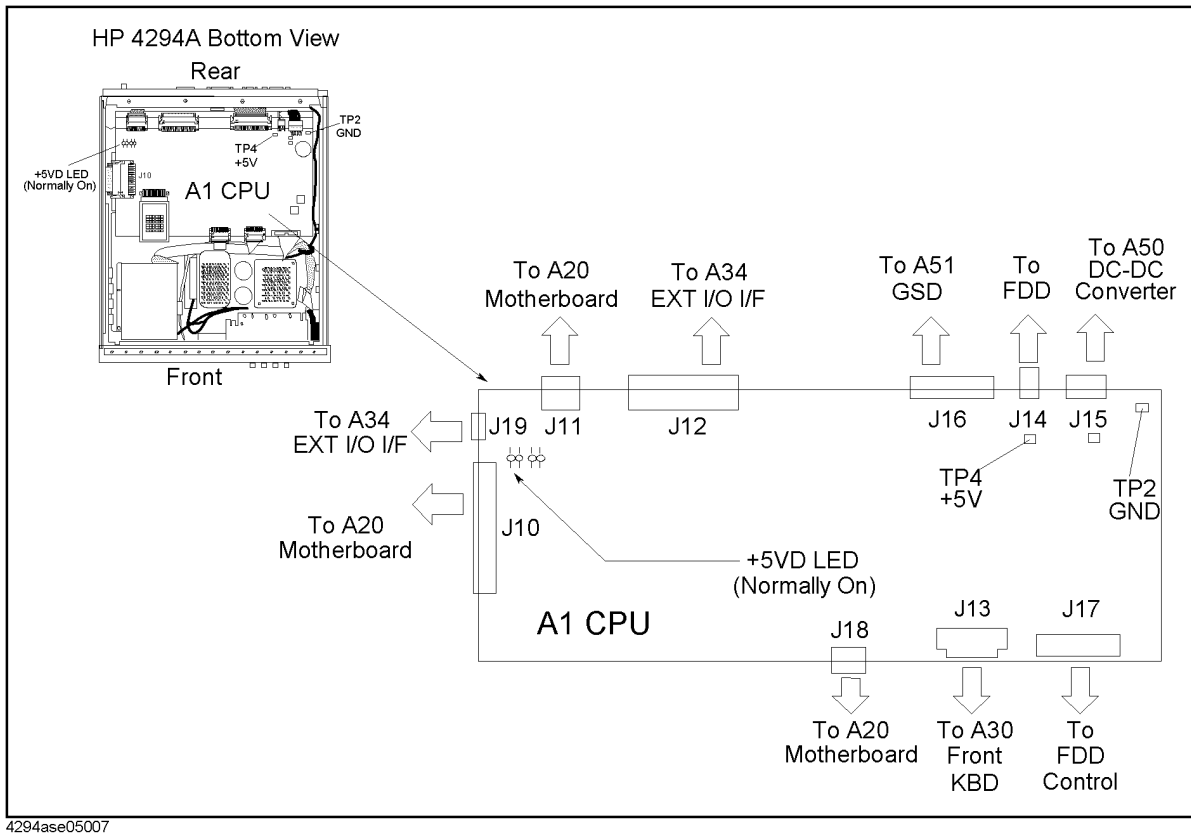
2. Measure the A1 +5VD Voltage

1. Reconnect the cable to A50P3. Turn the analyzer power on.
2. Check that the voltage between the TP4 (+5 V) and GND on A1 CPU is within +4.6 V to +5.4 V using a voltmeter with a small probe. The TP4 location on A1 CPU is shown in Figure 5-3.
 - If the voltmeter reading is not within these limits, inspect fuses on A1. The fuses on A1 CPU is shown in Figure 5-3.
 - If the fuses are verified but the voltmeter reading is still not within these limits, continue with the *Disconnect Cables on the A1 CPU*.

3. Disconnect Cables on the A1 CPU

1. Turn the analyzer power off.
2. Disconnect cables from the A1 CPU's connectors, J10, J11, J12, J13, J14, J16, J17, J18, and J19. Don't disconnect the J15. The connector locations are shown in Figure 5-8.

Figure 5-8 A1 CPU Connector Location



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3. Turn the analyzer power on. Look at the A1 +5 VD LED.
 - If the LED is still off, the A1 CPU is probably faulty. Replace the A1 CPU.
 - If the LED goes on, the A1 CPU is verified. Continue with the next step.
4. Turn the analyzer power off. Reconnect the cables to the A1J10, A1J11, and A1J18. Turn the analyzer power on. Look at the A1 +5 VD LED.
 - If the +5 VD LED goes off, the problem may be in the analog assemblies. Continue with *Remove Assemblies*.
 - If the + 5 VD LED is still on, continue with the next step.
5. Reconnect the disconnected cables to their connectors one at a time. Turn the analyzer power on after each cable is connected. The assembly related with the cable turning the +5 VD LED off is probably faulty. Replace the assembly.

3. Remove Assemblies

1. Turn the analyzer power off. Remove the assemblies A2, A3, A4, A5, A6, A7, A8, A51 and A91J from the A20 motherboard.
2. Turn the analyzer power on. Look at the A1 +5 VD LED.
 - If the LED is still off, inspect the A20 motherboard.
 - If the LED goes on, the A20 motherboard is verified. Continue with the next step.

FIND OUT WHY THE A1 +5 VD LED IS NOT ON STEADILY

3. Reinstall the removed assemblies one at a time. Turn the analyzer power on after each is installed. The assembly that turns the A1 +5 VD LED off is the most probable faulty assembly. Replace the assembly.

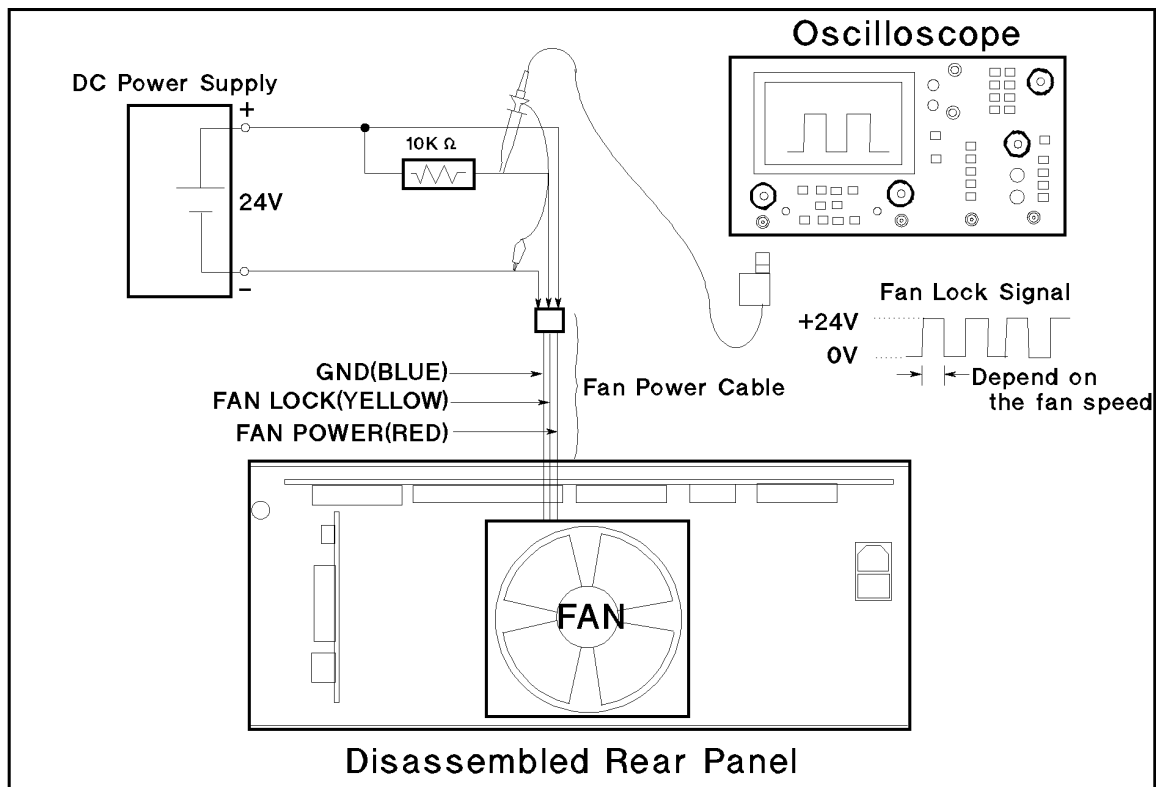
TROUBLESHOOT THE FAN AND THE A50 DC-DC CONVERTER

Perform the following procedure to troubleshoot the fan and the A50 DC-DC Converter.

1. Troubleshoot the Fan

1. Turn the analyzer power off.
2. Disassemble the rear panel.
3. Remove the fan power cable from the Motherboard A20J22.
4. Connect a DC power supply, a 10 k Ω resistance, and an oscilloscope to the fan power cable using appropriate wire as shown in Figure 5-9.

Figure 5-9 Fan Troubleshooting Setup



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5. Turn the DC power supply on. Adjust the output voltage to +24V.
6. Check the fan is rotating. Check the FAN LOCK signal is as shown in Figure 5-9
 - If the fan is not rotating or the FAN LOCK signal is unexpected, replace the fan.
 - If these are good, the fan is verified.
7. Reconnect the fan power cable to the Motherboard A20J22.

2. Troubleshoot the A50 DC-DC Converter

1. Turn the analyzer power off.
2. Remove the A50 from the A20 motherboard. The cable from the A50P2 and the cable from the A50P3 are connected.
3. Turn the analyzer power on.
 - If the A50 SHUTDOWN LED is still off, replace the A50 DC-DC Converter.
 - If one or more LEDs are still off, replace the A50 DC-DC Converter.
 - If the A50 SHUTDOWN LED goes on and Five LEDs go on, continue with *Measure the A50 Power Supplies*.

Measure the A50 Power Supplies

Measure the power supply voltages on A50 using a voltmeter with a small probe. See Table 5-1 for power lines, connector pins, and limits.

Table 5-1 A50 Power Supplies

Supply	Connector Pin	Range
+ 5 VD	TP5	+ 4.8 V to + 5.4 V
- 8 V	TP2	- 7.2 V to - 8.0 V
+ 8 V	TP1	+ 7.2 V to + 8.0 V
- 15 V	TP4	- 14.1 V to - 15.5 V
+ 15 V	TP3	+ 14.3 V to + 15.6 V

- If any of the power supply voltages are not within these limits, replace the A50.
- If all A50 power supply voltages are good, the A50 is verified.

6

Digital Control Troubleshooting

This chapter describes troubleshooting procedures to isolate the faulty assembly within the digital control functional group.

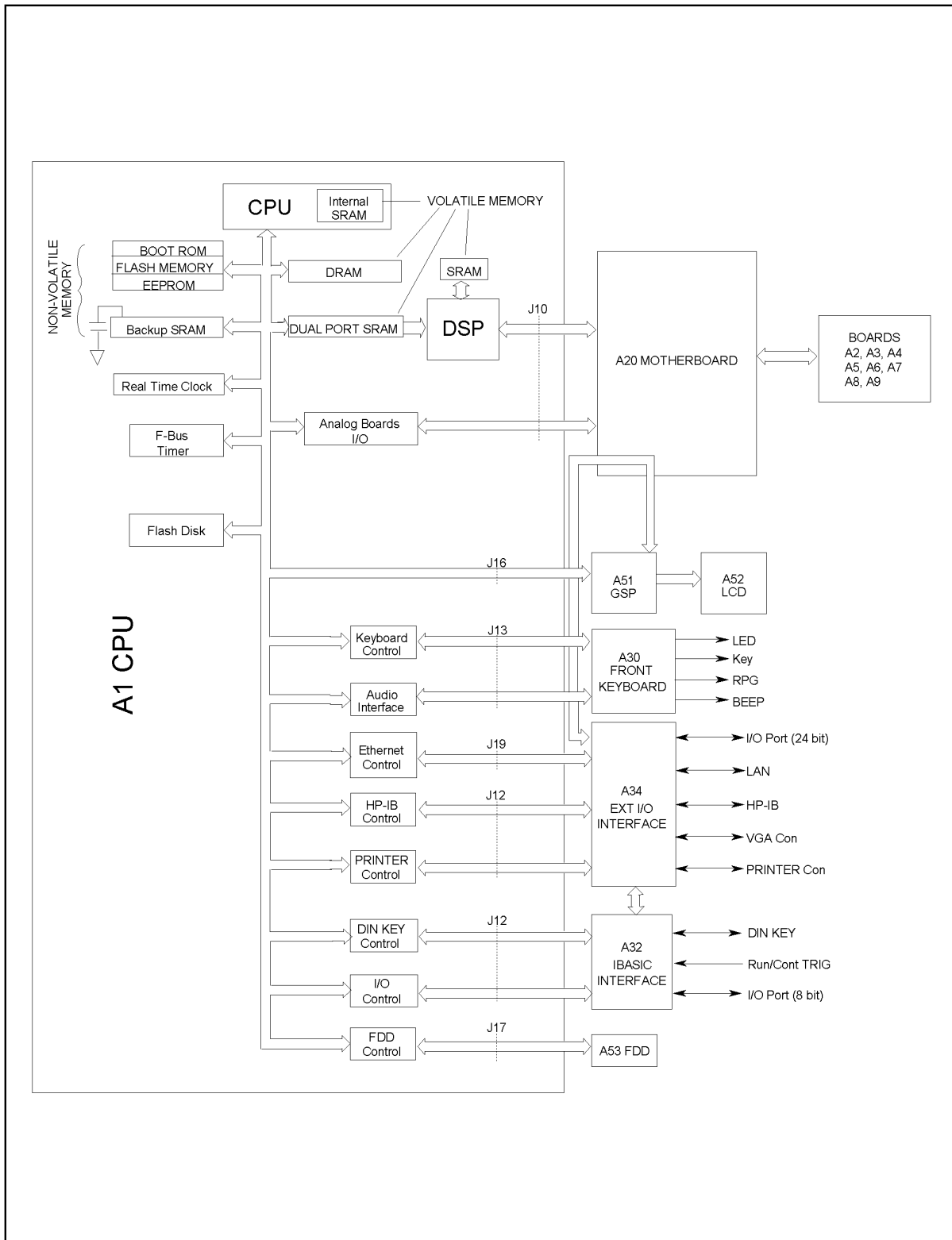
INTRODUCTION

Use this procedure only if you have followed the procedures in the *Troubleshooting* chapter, and believe the problem to be in the digital control group. This procedure is designed to let you identify the bad assembly within the digital control group in the shortest possible time. Whenever an assembly is replaced in this procedure, refer to the *Table of Related Service Procedures* in the *Post-Repair Procedures* chapter in this manual.

Figure 6-1 shows the digital control group in simplified block diagram form. The following assemblies make up the digital control group:

- A1 CPU
- A30 Front Keyboard
- A32 I-BASIC Interface
- A34 EXT I/O Interface
- A51 GSP
- A52 LCD (Liquid Crystal Display)
- A53 FDD

Figure 6-1 Digital Control Group Simplified Block Diagram



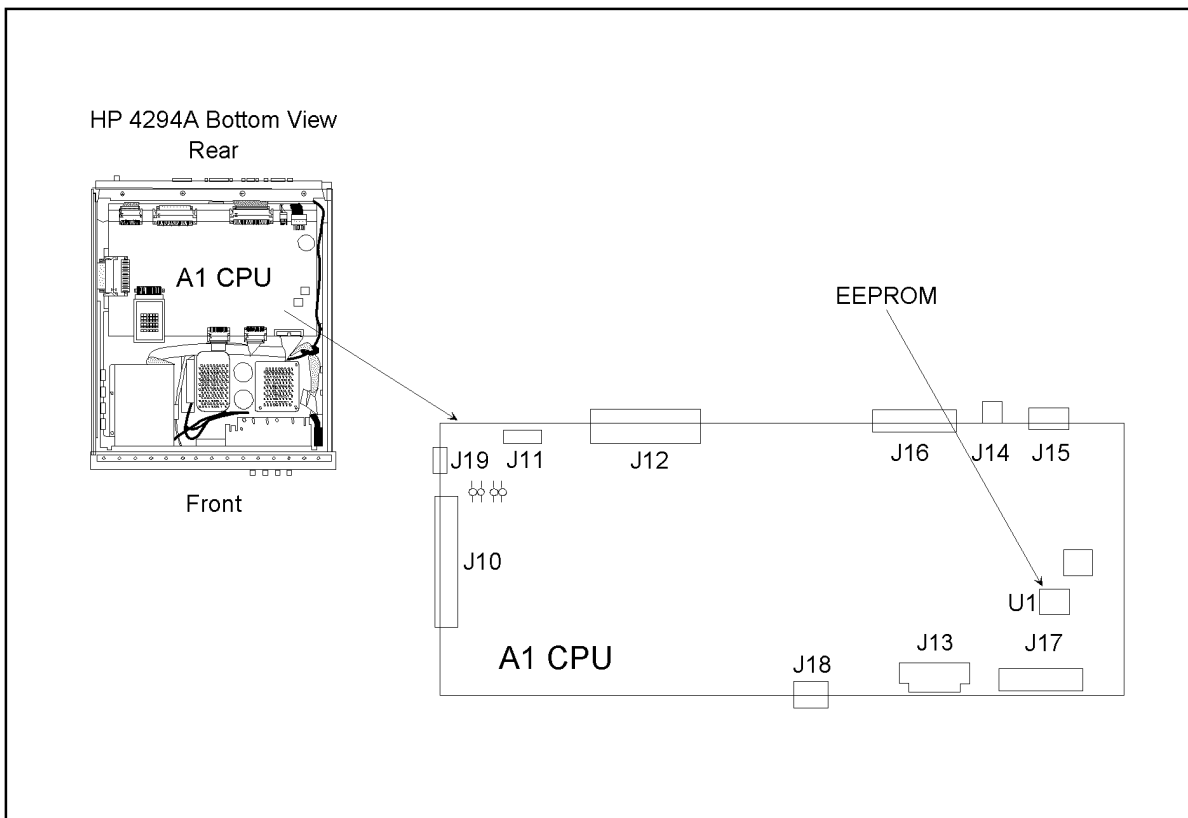
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A1 CPU Replacement

When you replace a faulty A1 CPU with a new one, remove the EEPROM from the faulty A1 and mount the EEPROM on the replacement A1.

In the EEPROM, the correction constants data is stored after performing the Adjustment and Correction Constants procedures described in chapter 3. The data may be valid for the new A1 CPU.

Figure 6-2 **A1 EEPROM Location**



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FIRMWARE INSTALLATION

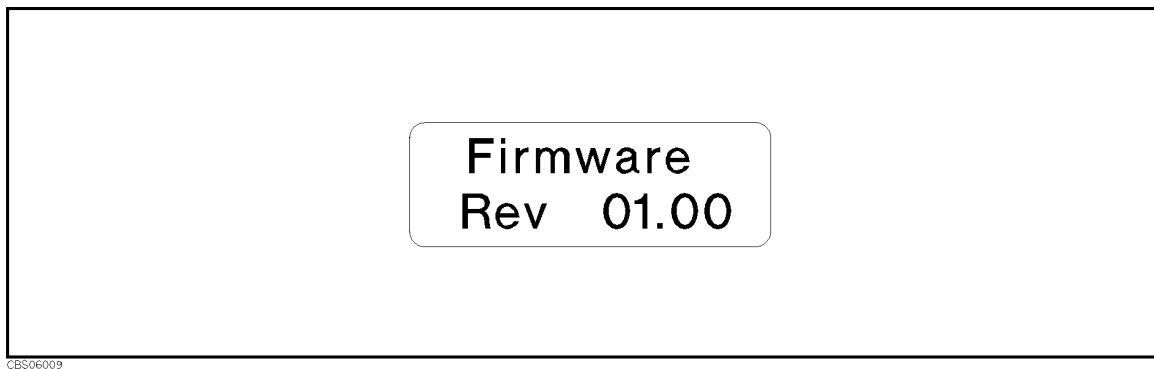
No firmware is installed in new A1 CPU assembly. When you replace a faulty A1 CPU with a new one, perform the following steps to install the firmware into the A1 CPU.

Ordering the Firmware Diskette

A firmware diskette (3.5 inch) that contains the analyzer's firmware is required for the firmware installation. If you do not have a firmware diskette, you must order one. For ordering information, contact your nearest Agilent Technologies service center and provide the revision of the analyzer's firmware. The part number of the firmware diskette depends on the firmware revision. The firmware revision of the analyzer is indicated on the revision label attached on the rear panel as shown in Figure 6-3.

Figure 6-3

Firmware Revision Label

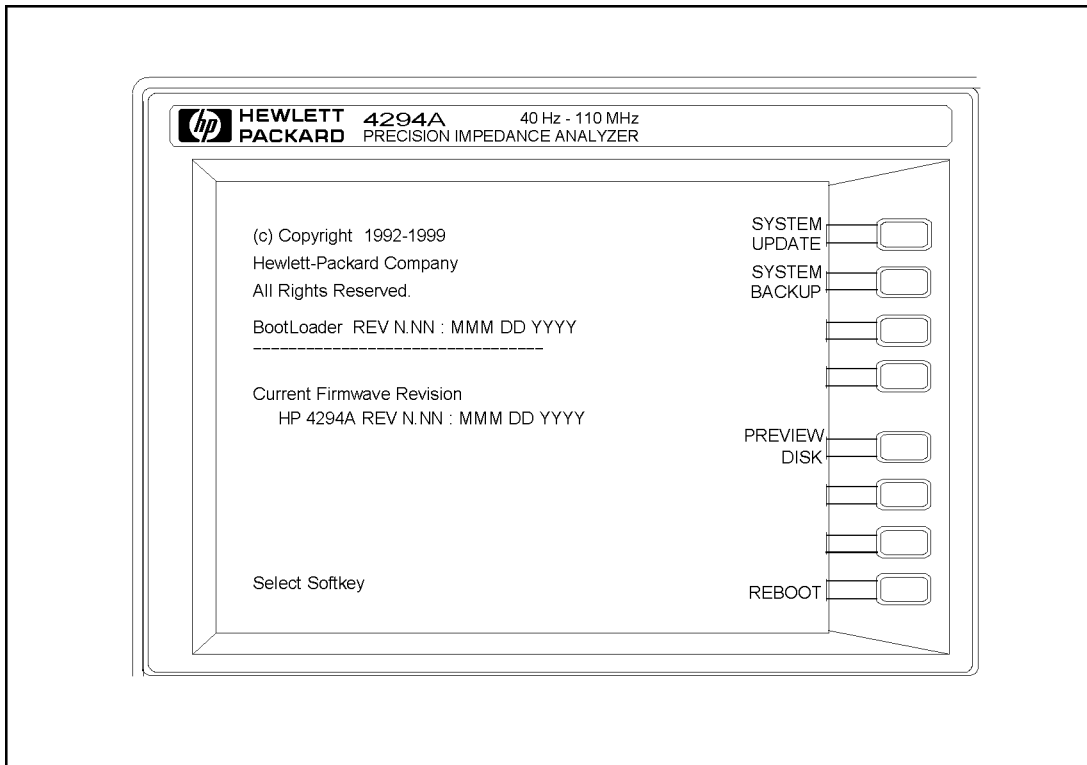


Installing the Firmware

Perform the following procedure to install the firmware into the analyzer.

1. Turn the analyzer power off.
2. Press the **[Preset]** key. While pressing the key, turn the analyzer power on.
3. Wait until the bootloader menu appears on the LCD as shown in Figure 6-4.

Figure 6-4 **Bootloader Menu Display**



4. Insert the firmware diskette into the floppy disk drive on the front panel.
5. Press **System UPDATE** and **CONTINUE**. The analyzer displays "Loading From Disk" and starts the firmware installation.
6. Wait until the analyzer displays "Update Complete."
7. Press **REBOOT** or turn the analyzer power off and on. The analyzer starts the operation using the installed firmware.
8. Verify that no error message is displayed and that the revision displayed is that of the revision label.
 - In case of unexpected results, inspect the firmware diskette for any damage. Clean the built-in FDD and retry the procedure.

START HERE

1. Check the Power-On Sequence

See the *INSPECT THE POWER-ON SEQUENCE* section in chapter 4 for checking the Power-On Sequence.

Check the [A] and [B] Operations

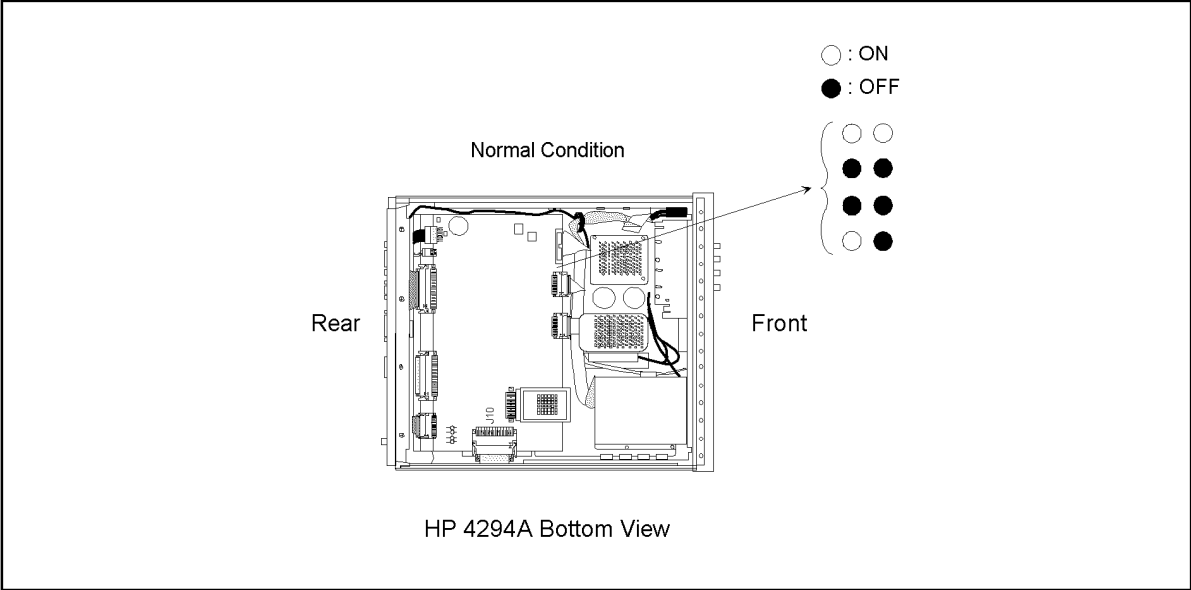
1. Press **[A]** and **[B]** alternately.
2. Check that the two LEDs alternately light each time you press the keys.
 - If both LEDs do not light, continue with *Check the A1 Eight LEDs*.
 - If the two LEDs do not alternately light (the **[A]** LED is still lit even if pressing the **[B]**), the A1 CPU is probably faulty. Replace the A1 CPU.
 - If the two LEDs alternately light each time you press the keys, the A1 CPU is probably working properly. Continue with the *TROUBLESHOOT THE A51 GSP AND A52 LCD* section in this chapter.

Check the A1 Eight LEDs

The A1 eight LEDs should be in the pattern shown in Figure 6-5 at the end of the power on sequence. Perform the following procedure to check the A1 eight LEDs.

1. Turn the analyzer turn off.
2. Remove the bottom cover of the analyzer.
3. Turn the analyzer power on.
4. Look at the A1 eight LEDs. Some of the LEDs light during the power on sequence. At the end of the power on sequence, the LEDs should stay in the pattern shown in Figure 6-5. If the LEDs stay in another pattern, the A1 CPU is probably faulty. Replace the A1 CPU.

Figure 6-5 A1 Eight LEDs' Pattern



2. Check the A1 CPU

1. Turn the analyzer power on.
2. Press **[System]**, **DIAGNOSTIC TEST**, **[1]**, **[x1]**, **RUN TEST** to run the internal test 1: A1 CPU.
3. Check the test result, PASS or FAIL, that is displayed at the end of the test.
 - If this test fails, replace the A1 CPU.
 - If this test passes, continue with the next *Check the A1 DRAM and Flash Memory*.

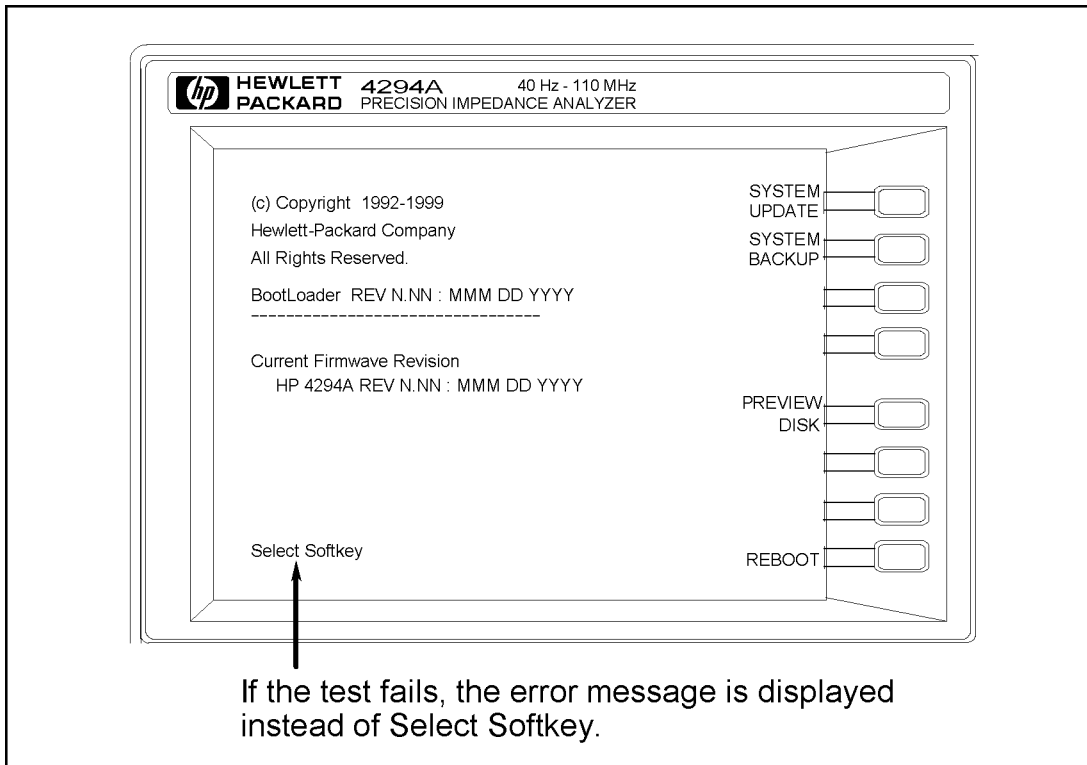
3. Check the A1 DRAM and Flash Memory

The A1 DRAM and flash memory are tested on the sequence to access the bootloader menu.

Perform the following procedure to verify the A1 DRAM and flash memory.

1. Turn the analyzer power off.
2. Push the **[Preset]** key. While keeping the key pushed down, turn the analyzer power on.
3. Wait for the display shown in Figure 6-6 to appear on the LCD.
4. Check that no error message is displayed on the LCD.
 - If no error message is displayed, the A1 DRAM and flash memories are verified. Continue with *Check the A1 Volatile Memory*.
 - If an error message is displayed or the display shown in Figure 6-6 does not appear, the A1 CPU is probably faulty. Replace the A1 CPU.

Figure 6-6 Bootloader Display



4. Check the A1 Volatile Memory

1. Turn the analyzer power on.
2. Press **[System]**, **DIAGNOSTIC TEST**, **[2]**, **[x1]**, **RUN TEST** to run the internal test 2: A1 VOLATILE MEMORY.
3. Check that no error message is displayed. At the end of this test, the analyzer returns the control settings to the default values (power on reset). If the test fails, the analyzer displays an error message for a few second before returning to the defaults.

- If no error message is displayed, the A1 volatile memories are verified. Continue with *Check the A30 Front Keyboard*.
- If one of the error messages listed below is displayed, the A1 CPU is faulty. Replace the A1 CPU.

“CPU INTERNAL SRAM R/W ERROR”

“DSP SRAM R/W ERROR”

“DUAL PORT SRAM R/W ERROR”

“CPU BACKUP SRAM R/W ERROR”

5. Check the A30 Front Keyboard

The A30 front keyboard can be checked using the external test 17: FRONT PANEL.

1. Press **[Preset]**, **[System]**, **DIAGNOSTIC TEST**, **[1]**, **[7]**, **[x1]**, **RUN TEST** to run the external test 17.

2. Press all of the front panel keys. The abbreviated key name should be displayed when a key is pressed. When you rotate the RPG knob, the RPG tuned direction (CW or CCW) and its response speed (SLOW, MID, FAST) should be displayed. You can check every key on the A30 Keyboard except for **[Preset]**. (If you want to exit this test, press **[Preset]**.)
 - If one or more keys seems to be defective, replace the A30 front keyboard.
 - If all keys seem to be good, the A30 front keyboard is verified. Continue with the next *Check the A53 FDD*.

6. Check the A53 FDD

The A53 FDD (Flexible Disk Drive) can be checked using the external test 18: FLOPPY DISK DRIVE.

1. Press **[Preset]**, **[System]**, **DIAGNOSTIC TEST**, **[1]**, **[8]**, **[x1]**, **RUN TEST** to run the external test 18.
2. As the analyzer instructs, insert a flexible disk into FDD. Use a formatted but blank flexible disk, otherwise the data on the disk will be overwritten by this test. Then press **CONT**.
3. Check the test result, PASS or FAIL, that is displayed at the end of the test.
 - If this test fails, replace the A53 FDD.

7. Check the A32 I-BASIC Interface and the mini DIN Keyboard

The mini DIN external keyboard is connected to the A32 I-BASIC I/O connector, and is used to develop programs.

If the external keyboard of the I-Basic is not working, perform the following procedure to verify the keyboard.

Press **[Preset]**, **[System]**, **DIAGNOSTIC TEST**, **[1]**, **[x1]**, **RUN TEST** to run the internal test 1: A1 CPU.

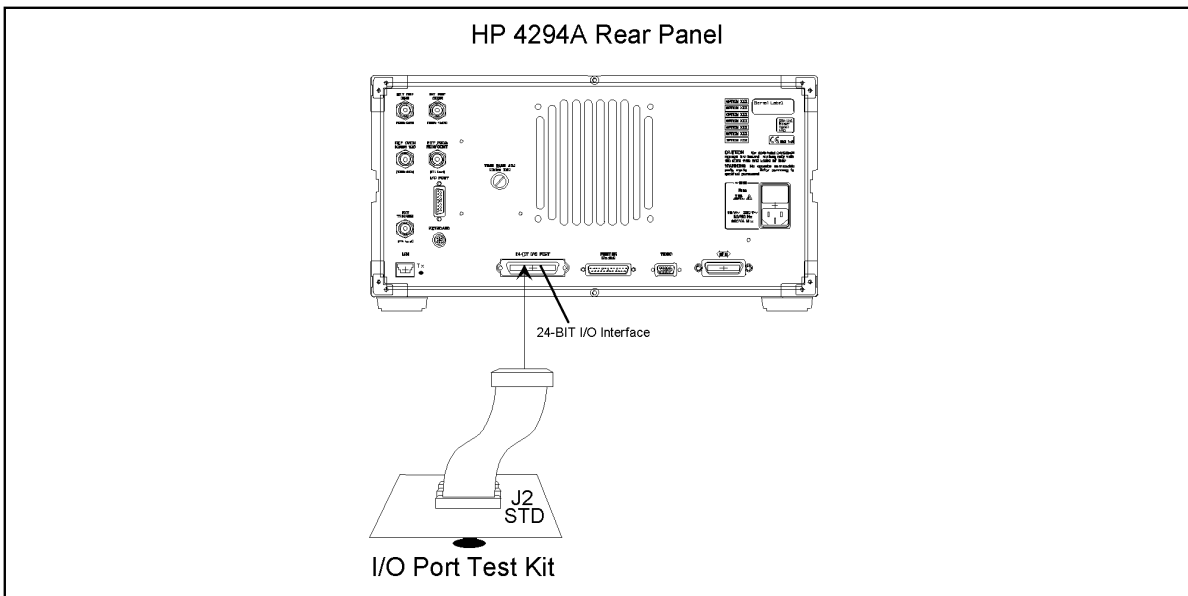
- If the internal test 1 passes, the HP driver circuit on the A1 CPU is probably working. Inspect cables between the external keyboard and the A1 CPU through the A32 I-BASIC interface. If the cable is good, replace the external keyboard.
- If the internal test 1 fails, replace the A1 CPU.

8. Check the 24 BIT I/O PORT

Perform the following procedure to verify the 24 BIT I/O PORT using the I/O Port Test Kit (PN 87510-65002). The 24 BIT I/O PORT is connected to the I/O control on A51 board through the A20 motherboard.

1. Turn the analyzer off.
2. Connect the I/O Port Test Kit to the 24 BIT I/O PORT on the analyzer's rear panel as shown in Figure 6-7.

Figure 6-7 24 BIT I/O PORT Test Setup



4294ase06006

3. Turn the analyzer power on.
4. Press **[Preset]**, **[System]**, **DIAGNOSTIC TEST**, **[1]**, **[9]**, **[x1]**, **RUN TEST** to run the external test 19: 24 BIT I/O.

 - If the external test 19 passes, the 24 BIT I/O PORT is verified.
 - If the external test 19 fails, replace the A51 GSP.

9. Check the LAN Operation

Perform the following procedure to verify the LAN operation. Before connecting the analyzer with LAN, you set an IP address, a gateway IP address, and a sub-net mask that your network administrator assigned to your analyzer.

1. Press **[Local]**, **IP ADDRESS**, **1st**, and enter the first number of the IP address delimited by a period.
2. Press **2nd**, **3rd**, **4th**, and similarly enter the second, the third, and the fourth number of the IP address delimited by a period.
3. Press **done**.
4. Press **[Local]**, **GATEWAY ADDRESS**, **1st**, and enter the first number of the IP address delimited by a period.
5. Press **2nd**, **3rd**, **4th**, and similarly enter the second, the third, and the fourth number of the IP address delimited by a period.
6. Press **done**.
7. Press **[Local]**, **SUBNET MASK**, **1st**, and enter the first number of the sub-net mask delimited by a period.
8. Press **2nd**, **3rd**, **4th**, and similarly enter the second, the third, and the fourth number of the sub-net mask delimited by a period.

9. Press **done**.
10. Connect a 10Base-T twisted pair “straight-through” cable (Ethertwist) from your network to the LAN port (RJ-45 connector) of the analyzer’s rear panel.

NOTE

It is possible to connect a single computer to a single analyzer, and avoid using a LAN hub. To do this, you must use a special “cross-over” cable or adapter, which acts like a LAN hub.

11. Turn the analyzer power off and turn the analyzer power on.
12. Run Ping command under Windows NT or 95. At the command prompt of a DOS window, type:

ping <IP address>

Where <IP address> is the number you entered into the analyzer in the step above.

See below for an example output on the DOS windows of a successful ping.

Pinging <IP address> with 32 bytes of data:

```
Reply from <IP address> : bytes=32 time<10ms TTL=60
Reply from <IP address> : bytes=32 time<10ms TTL=60
Reply from <IP address> : bytes=32 time<10ms TTL=60
Reply from <IP address> : bytes=32 time<10ms TTL=60
```

- If the analyzer fails to ping, then the fault must be isolated to the analyzer or to the network.

TROUBLESHOOT THE A51 GSP and A52 LCD

Use this procedure when the LCD (Liquid Crystal Display) is unacceptable, or not being bright.

1. Run the Internal Test 4: A51 GSP.

The A51 GSP can be checked using the internal test 4: A51 GSP.

1. Press **[Preset]**, **[System]**, **DIAGNOSTIC TEST**, **[4]**, **[x1]**, **RUN TEST** to run the internal test 4.
2. Check the test result, PASS or FAIL, that is displayed at the end of the test.
 - If this test fails, replace the A51 GSP.

2. Check the A52 LCD (Liquid Crystal Display)

The A52 LCD can be tested using the display test 27 to 31.

1. Press **[Preset]**, **[System]**, **DIAGNOSTIC TEST**, **[2]**, **[7]**, **[x1]**, **RUN TEST** to run the display test 27, and run the other tests with the same manner.
2. If there are any defects on the LCD, replace the A52 LCD.
3. If no correct patterns are displayed, check the A54 Inverter.

7

Service Related Menus

This chapter describes the functions of the diagnosis key menus. These menus are used to test, verify, and troubleshoot the 4294A.

DIAGNOSTIC TEST Menu

The diagnosis key menus consist of several menus that are accessed through the diagnosis menu. The diagnosis menu is displayed by pressing **[System]**, **DIAGNOSTIC TEST**.

When the GPIBGPIB commands are applicable, follow the keystrokes in parentheses. The *<numeric>* listed below specifies the test number and is an integer from 0 to 31.

RUN TEST (:DIAG:TEST:EXEC)

Runs the selected test. When the executed test requires user interaction, **CONTINUE** (:DIAG:TEST:CONT) and the instruction appear on the display. Follow the displayed instruction and press **CONTINUE** to continue the test.

INTERNAL TEST (:DIAG:TEST *<numeric>*)

These tests are completely internal and self-evaluating. They do not require external connection or user interaction. The 4294A has 16 internal tests.

EXTERNAL TEST (:DIAG:TEST *<numeric>*)

These are additional self-evaluating tests. However, these tests require some user interaction. The 4294A has 10 external tests.

DISPLAY TEST (:DIAG:TEST *<numeric>*)

These tests are used to check for proper operation of the display circuits. The 4294A has 5 display tests.

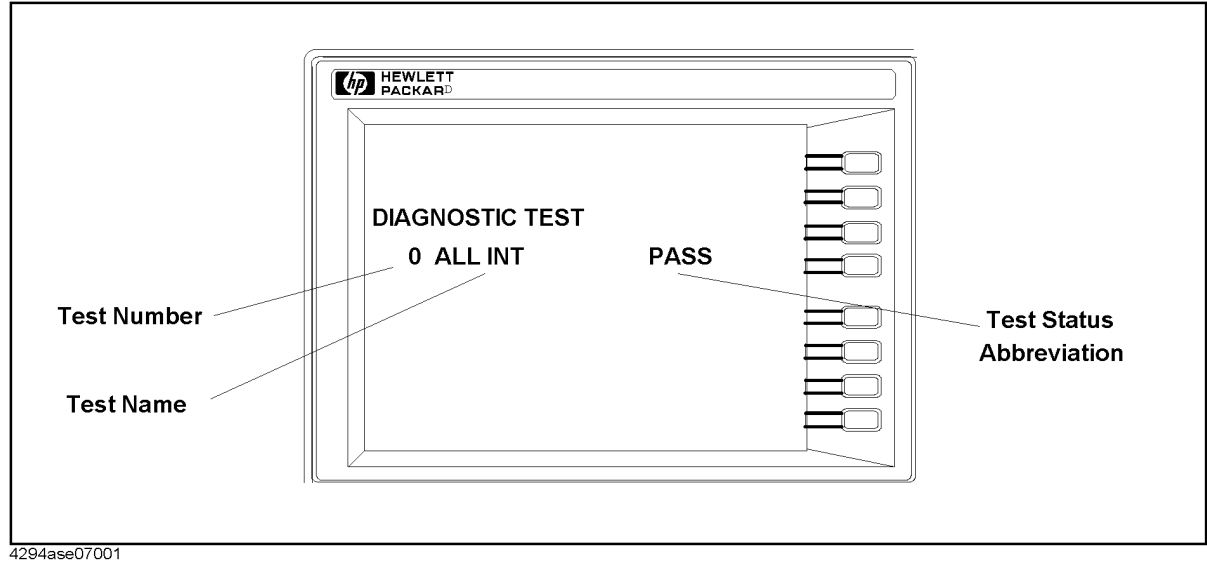
NOTE	After executing a test by pressing RUN TEST , an annotation (Svc) is displayed to indicate which tests are executing and that the analyzer settings are changed to test settings. To return the analyzer to normal operation, cycle the analyzer power (off and on), or press [Preset] .
-------------	--

NOTE	While any test is being executed, do not change any analyzer setting using the front-panel keys, the GPIB, or I-BASIC program. If the setting is changed during test execution, the test result and the analyzer operation will be unreliable.
-------------	--

Test Status

When selecting a test, the test status abbreviation is displayed as shown in Figure 7-1.

Figure 7-1 **Test Status on the Display**



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To see the test status of the desired test, enter the desired test number using the numeric keypad, [↑], [↓], or RPG knob. Also, the GPIB commands listed below are available to get the status using GPIB.

- :DIAG:TEST:RES? <numeric>

returns the test status. The <numeric> specifies the test number and is an integer from 0 to 31.
- *TST?

executes internal test 0: ALL INTERNAL and returns the test result.

Table 7-1 shows the test status abbreviation, its definition, and the GPIB test status code.

Table 7-1 **Test Status Terms**

Status Abbreviation	Definition	GPIB Code
PASS	Pass	“PASS”
FAIL	Fail	“FAIL”
BUSY	In progress	“BUSY”
NDON	Not done	“NDON”
DONE	Done	“DONE”

The test status is not stored in nonvolatile memory (battery backup memory). When the analyzer is turned off and on, the analyzer sets test status abbreviation except the power-on self test (internal tests 5 to 16) to “NDONE” (Not done). If a test is aborted by pressing any key during its execution, the test status is undefined.

Test Descriptions

This section describes all 31 diagnostic tests.

INTERNAL TEST

This group of tests run without external connections or operator interaction. All return a “PASS” or “FAIL” indication on the display. Except as noted, all are run during the power on self-test.

0: ALL INTERNAL

Runs only when selected. It consists of internal tests 1 through 16. If any of these tests fail, this test displays the “FAIL” status indication. Use the RPG knob to scroll through the tests to see which test failed. If all pass, the test displays the “PASS” status indication. Each test in the subset retains its own test status.

1: A1 CPU

Runs only when selected. It verifies the following circuit blocks on the A1 CPU:

- Flash Memory Check Sum
- EEPROM Check Sum
- Digital Signal Processor (DSP)
- System Timer
- Real Time Clock
- Front key Controller
- Flexible Disk Driver Controller
- GPIB Controller
- mini-DIN Controller
- Ethernet Controller
- PC Card ATA Controller

2: A1 VOLATILE MEMORY

Runs only when selected. It verifies the A1 volatile memories:

- DSP SRAM
- Dual Port SRAM
- Backup SRAM

At the end of the test, the analyzer is set to the power-on default state because the data in the tested memories has been destroyed. During this test, a test pattern is written into the memories and then the pattern is read back and checked.

If the test fails, the test displays an error message for a few seconds and then sets the analyzer to default state. The error message indicates the faulty memory.

3: A1 FLASH DISK

Runs only when selected. It verifies the flash disk circuit block on the A1 CPU.

4: A51 GSP

Runs only when selected. It verifies the GSP chip and VRAM circuit blocks on the A51 GSP.

5: ADJUST DATA

Verifies that all correction constants which compensate for the hardware performance of the analyzer are stored in the EEPROM on A1 CPU.

6: BOARD ID

Checks the board IDs, A2, A3, A4, A5, A6, A7, A8, and A9 board.

7: A8 A/D CONVERTER

Verifies the A/D converter in the A8 Vector Ratio Detector. This test measures the following frequency bus nodes and DC bus nodes. It then checks that each measured value is within limits.

- A/D Clock frequency bus
- A/D Sequencer frequency bus
- 2nd LO frequency bus
- 0 V input DC bus
- 1.2 V input DC bus

8: A3 DC POWER SOURCE

Verifies A3 power regulator output voltages, +5 V, -12 V, +12 V. This test measures the regulator output voltages at DC bus nodes. It checks that each measured value is within limits.

9: A4 DC POWER SOURCE

Verifies A4 power regulator output voltages, Float, LFOUT, HFOUT. This test measures the regulator output voltages at DC bus nodes. It checks that each measured value is within limits.

10: A7 DC POWER SOURCE

Verifies A7 power regulator output voltages, 5VRF, 5VN, -8 V, -12 V, +12 V. This test measures the regulator output voltages at DC bus nodes. It checks that each measured value is within limits.

11: A8 DC POWER SOURCE

Verifies A8 power regulator output voltages, -5 V, +5 V, -12 V, +12 V. This test measures the regulator output voltages at DC bus nodes. It checks that each measured value is within limits.

12: A6 IF FREQUENCY

Verifies IF signals (230kHz/250kHz) in the A6. This test measures the frequencies at a frequency bus node. It checks that each measured value is within limits.

13: A7 IREF D/A

Verifies the D/A converter in the A7. This test measures the VCXO tuning voltage at a DC bus node. It checks that the measured value is within limits.

14: A7 OSCILLATION

Verifies the oscillator circuit in the A7. This test measures the PLL signal (230kHz) and IF

(230kHz) signal at a frequency bus node. It checks that each measured value is within limits.

15: A2/A9 AC OSC LEVEL

Verifies the source circuit in the A2. This test measures the signal level at low frequencies with the A/D converter in the A2. It checks that the measured value is within limits. It also checks the floating section control signal of the A2.

16: A2/A9 DC BIAS LEVEL

Verifies the DC bias circuit in the A2. This test measures the DC bias level with the A/D converter in the A2. It checks that the measured value is within limits. It also checks the floating section control signal of the A2.

EXTERNAL TEST

This group of tests requires either external equipment and connections or operator interaction to run. All return a “PASS” or “FAIL” indication on the display except the external test 17.

17: FRONT PANEL

Checks the RGP and all front panel keys on the A30 keyboard. The abbreviated name is displayed by pressing one of the keys or by rotating the RPG.

18: FLOPPY DISK DRIVE

Checks the FDD (Flexible Disk Drive). A formatted, blank disk is required. When this test is started, a bit pattern is written onto the flexible disk. The pattern is then read back and checked. This write pattern check is repeated from the low to high addresses.

19: 24 BIT I/O

Checks the 24-BIT I/O Port function on rear panel. This test requires I/O Port Test Kit (PN 87510-65002). For a more detailed procedure, refer to the *Digital Control Troubleshooting*.

20: ALL ANALOG

It consists of external tests 21 through 26. This test requires an OPEN termination (42090A) or two BNC cables. The tests are done sequentially. If an external test is failed while performing this test, it stops testing. It then displays the external test item which is failed and the “FAIL” status. If all pass, it displays the “PASS” status. The internal test ALL INT must be done and passed before this test is performed. At the end of the test, the adapter selection of the analyzer is changed to the “NONE” status.

21: A8 IF

Checks the attenuator circuit in the A8. This test requires an OPEN termination (42090A) or two BNC cables. It must be done before external tests 22, 23, 24, 25, or 26 are performed. At the end of the test, the adapter selection of the analyzer is changed to the “NONE” status.

22: A3 VCH / A8 FRONTEND

Checks the circuit in the A3 which senses the voltage across the DUT and transmits the signal to the A8, it also checks the circuit in the A8 which transmits the signal to the 1st mixer in the A8. This test requires an OPEN termination (42090A) or two NC cables. It must be done before external tests 23, 24, 25, or 26 are performed. At the end of the test,

the adapter selection of the analyzer is changed to the “NONE” status.

23: A2 ATT

Checks the attenuator circuit in the A2 which generates the signal level. This test requires an OPEN termination (42090A) or two BNC cables. It must be done before external tests 24, 25, or 26 are performed. At the end of the test, the adapter selection of the analyzer is changed to the “NONE” status.

24: A5 NULL FRONT

Checks the input amplifier circuit in the A5. This test requires an OPEN termination (42090A) or two BNC cables. It must be done before external tests 25 or 26. At the end of the test, the adapter selection of the analyzer is changed to the “NONE” status.

25: A4/5/6 NULL

Checks the null loop circuit which is constructed by the A4, A5, and A6. This test requires an OPEN termination (42090A) or two BNC cables. It must be done before external test 26. At the end of the test, the adapter selection of the analyzer is changed to the “NONE” status.

26: A3 ICH / A4

Checks the circuit in A4 which senses the voltage across the range resistor and transmits the signal to the A3, it also checks the circuit in the A3 which transmits the signal to the A8. This test requires an OPEN termination (42090A) or two BNC cables. At the end of the test, the adapter selection of the analyzer is changed to the “NONE” status.

DISPLAY TEST

These tests are test patterns used to inspect the LCD display. Test patterns are executed by entering the test number (27 through 31), then pressing **RUN TEST**. The test pattern is displayed and the softkey labels are blanked. After a few seconds, the test pattern is exited and return to softkey labels.

27: TEST PATTERN 1

ALL Black. This pattern is used to verify the color purity of the LCD Display.

28: TEST PATTERN 2

ALL White. This pattern is used to verify the light output and to check the color purity of the LCD Display.

29: TEST PATTERN 3

ALL Red. This pattern has the same use as TEST PATTERN 2.

30: TEST PATTERN 4

ALL Green. This pattern has the same use as TEST PATTERN 2.

31: TEST PATTERN 5

ALL Blue. This pattern has the same use as TEST PATTERN 2.

8 Theory of Operation

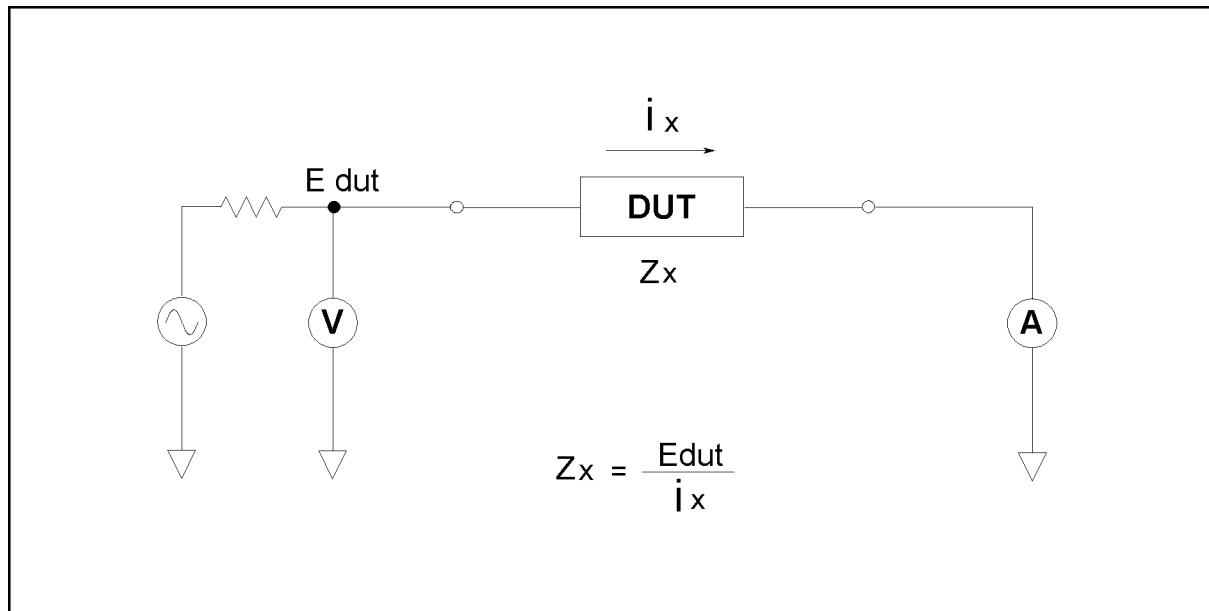
This chapter describes the general overall operation of the 4294A and the operation of each functional group. The operation of each group is described to the assembly level only. Detailed component-level circuit theory is not provided in this manual.

OVERALL OPERATION

OVERALL MEASUREMENT THEORY

The 4294A measures the impedance of the Device Under Test (DUT) by measuring vector voltage to current ratio. A vector is a value which consists of a magnitude and a phase. The impedance of the DUT is determined by the vector ratio between the voltage across the DUT and the current flowing through it. Figure 8-1 illustrates this principle

Figure 8-1 Voltage Current Ratio Measurement Principle



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In Figure 8-1, a DUT is connected in series with a test voltage source (including an output resistance), voltmeter V, and ammeter A. If the ammeter measures “ix” ampere when the source voltage is “Edut”, the DUT’s impedance “Zx” is , “Zx=Edut/ix”. The other parameters, such as L, C, and R, are derived mathematically from the measured impedance value. The 4294A employs the most accurate measurement technique (Auto-Balancing-Bridge) to measure the voltage across the DUT and the current through it.

OVERALL OPERATION AND FUNCTIONAL GROUPS

The 4294A consists of five main functional groups: a power supply, a digital control, a source, a transducer, and vector ratio detector. Each group consists of several major assemblies, and performs a distinct function in the 4294A. However, all the groups are interrelated to some extent and affect each other’s performance.

Power Supply: The power supply functional group consists of the A40 preregulator, the A50 DC-DC Converter, and the A9 Floating Power Supply. It supplies power to the other assemblies in the analyzer.

Digital Control: The digital control group consists of the A1 CPU, the A30 keyboard, the A34 I/O connector, the A32 Instrument BASIC interface, the A51 GSP(Graphics System

Processor), the A52 LCD, and the A53 FDD. These assemblies combine to provide digital control for the analyzer.

Source: The source group consists of the A7 synthesizer, the A2 Hc Amp., and the A60 high stability frequency reference(option 1D5 only). The source generates all analog signals in the analyzer, a phase-locked test signal to the device under test, a DC bias signal to the device under test, IF signals for the transducer group and the vector ratio detector, and a sampling signal for the A/D converter.

Transducer: The transducer group consists of the A3 Hp Amp., A4 Lc Amp., A5 IV Converter & Lp Amp., and the A6 Vector Generator. The transducer group balances the range resistor current with the DUT current to maintain a zero potential at the low terminal(Lp) and transforms the DUT impedance, or admittance, into two AC signals.

Vector Ratio Detector: The A8 board is the vector ratio detector. The vector ratio detector converts the two AC signals from the transducer group into digital data.

The following pages describe the operation of the functional groups.

Simplified block diagrams illustrate the operation of each functional group. The detailed analog section block diagram is provided at the end of this chapter.

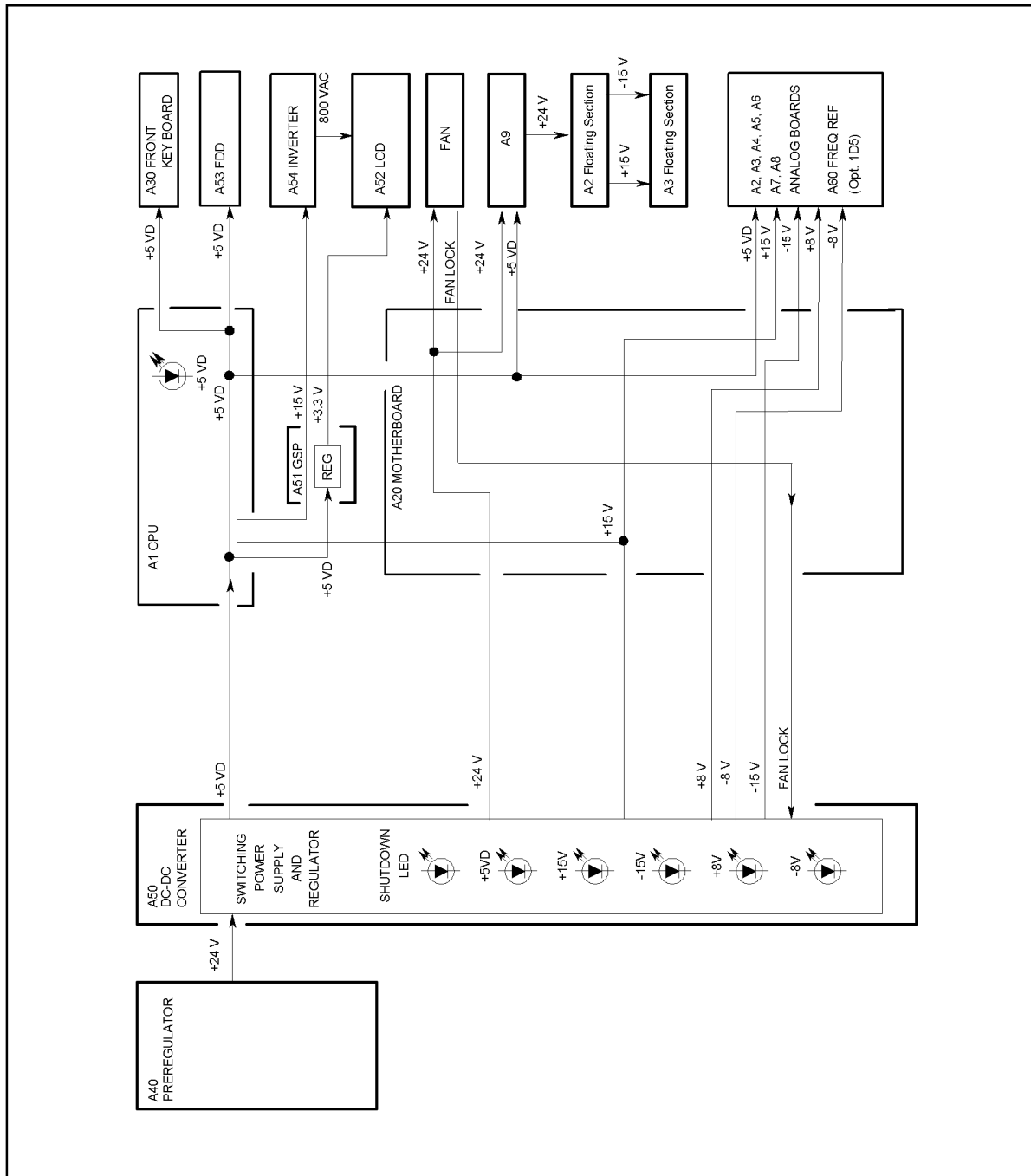
POWER SUPPLY OPERATION

The power supply functional group consists of the following assemblies:

- A40 Preregulator
- A50 DC-DC Converter
- A9 Floating Power Supply

These assemblies comprise a switching power supply that provides regulated DC voltages to power all assemblies in the 4294A. See Figure 8-2.

Figure 8-2 Power Supply Functional Group, Simplified Block Diagram



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Line Power Module

The line power module includes the main fuse. The main fuse, which protects the input side of the preregulator from drawing too much line current, is also accessible at the rear panel. See *Power Requirements* in appendix B for the fuse replacement and other power considerations.

A40 Preregulator

The A40 preregulator contains a rectifier and a switching regulator, converts the line voltage to + 24 V and provides it to the A50 DC-DC converter.

A50 DC-DC Converter

The A50 DC-DC Converter consists of the two switching regulators. The DC-DC converter provides LEDs(red) to indicate circuit status. The shutdown LED is turned off when the overcurrent protection circuit activates. The circuit activates when an overcurrent is sensed on the +5VD power line, when an overcurrent is sensed on the four power supplies ($\pm 8V$ and $\pm 15V$), or when the FAN LOCK signal is sensed. It shuts down the five power supplies of the switching regulators.

Regulated + 5V Digital Supply(+ 5VD)

The +5VD power supply is fully regulated in the A50 DC-DC converter. It goes directly to the A1 CPU and is supplied to all assemblies requiring a digital + 5V supply through the A1, and the A20 motherboard.

A50 Shutdown LED

The A50 shutdown LED is on during normal operation. It turns off when the A50 protective circuits are activated and shut down some power lines. The shutdown LED turns off when one of the following conditions is sensed:

- Overcurrent on + 5 VD power line
- Overcurrent on the four power supplies ($\pm 8 V$ and $\pm 15 V$)
- Fan is not rotating (FAN LOCK signal is sensed)

The fan obtains its power + 24 V from A40 preregulator through the A50 DC-DC converter. When the power is missing, the FAN LOCK signal shuts the switching regulators down and turns the A50 shutdown LED off.

A9 Floating Power Supply

The A9 floating power supply distributes the + 24 V power supply voltage to the A2 Hc Amp. The A9 floating power supply is equipped with a protective shutdown circuit. The A9 floating power supply provides two LEDs to indicate circuit status.

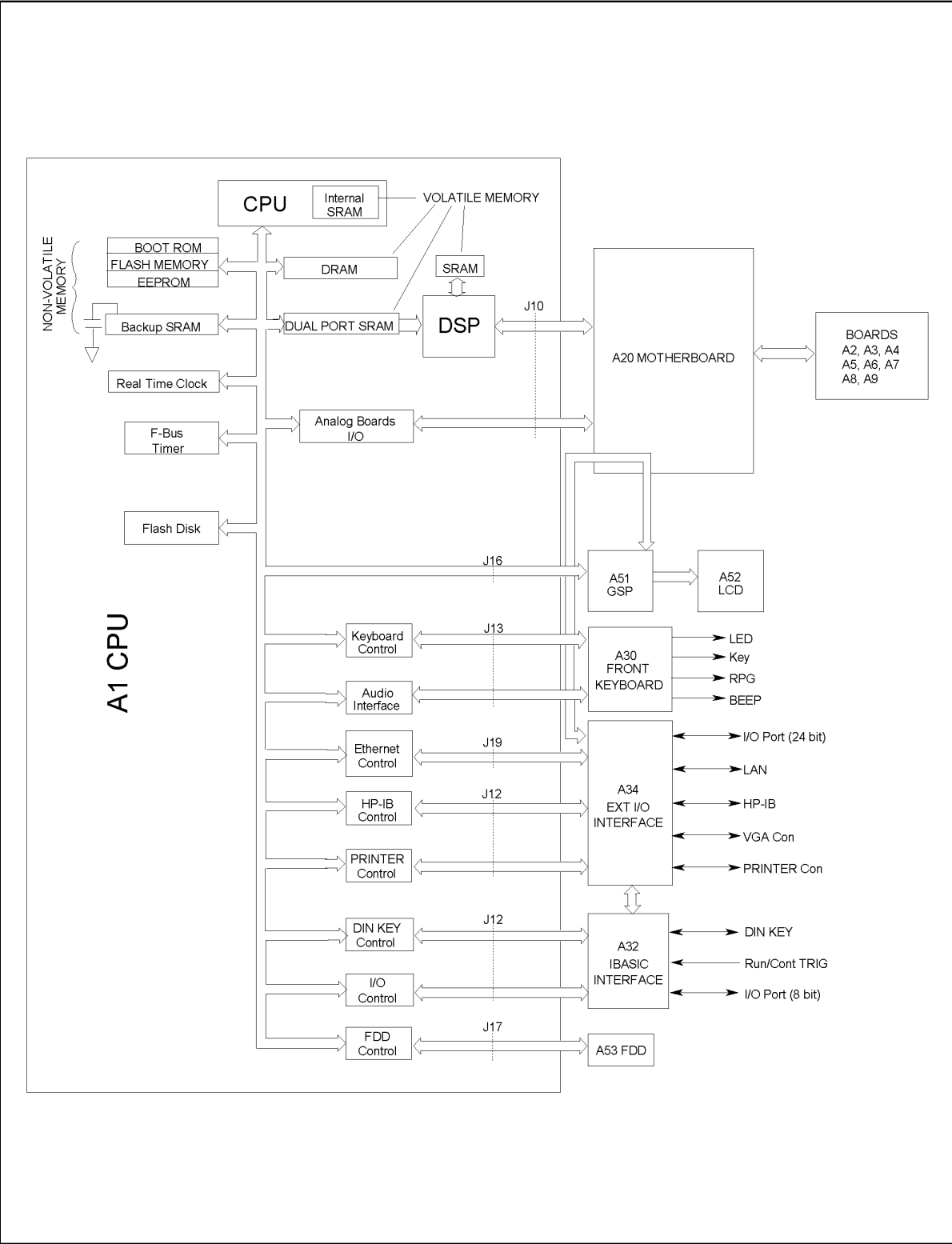
DIGITAL CONTROL OPERATION

The digital control functional group consists of the following assemblies:

- A1 CPU
- A30 Front Keyboard
- A32 I-BASIC Interface
- A34 I/O Connector
- A51 GSP
- A52 LCD
- A53 FDD

These assemblies combine to provide digital control for the 4294A. They provide math processing functions, as well as communications between the 4294A and an external controller and/or peripherals. Figure 8-3 is a simplified block diagram of the digital control functional group.

Figure 8-3 Digital Control Group Simplified Block Diagram



4294ase06001

A1 CPU

The A1 CPU consists of the following circuits and parts:

CPU	central processing unit that controls the analyzer.
DSP	digital signal processor that is used for fast data processing.
Memory storages	consists of BOOT ROMs, Flash Memory, EEPROM, Backup SRAM, DRAM, and Dual Port SRAM. The backup SRAM is powered from a large capacitor that is charged when the analyzer is turned on. Therefore, the SRAM keeps its data at least 72 hours after the analyzer is turned off. The Dual Port SRAM is used for communication between the CPU and DSP.
F-Bus Timer	is used in the frequency bus measurement that is a diagnostic function of the analyzer.
Analog Board Interface	interfaces between the CPU and analog assemblies.
Keyboard Control	controls the A30 front-panel keyboard.
Audio Interface	controls the beeper on A30 front-panel keyboard.
Ethernet Control	communicates with the LAN network through the LAN port on the A34 I/O connector.
GPIB Control	communicates with the external GPIB devices through the GPIB connector on the A34 I/O connector.
mini-DIN Control	interfaces between the CPU and the external keyboard through the mini-DIN connector on the A32 I-BASIC Interface.
I/O Control	controls external devices through the I/O PORT connector on the A32 I-BASIC interface. It also interfaces between the CPU and the external inputs through the EXT PROG RUN/CONT connector.
FDD Control	controls the A53 FDD.

A30 Front Keyboard

The A30 front keyboard assembly detects your inputs(key inputs and RPG inputs) from the front panel of the 4294A, and transmits them to the keyboard controller on the A1.

A32 I-BASIC Interface

The A32 I-BASIC Interface is the board with three connectors: the EXT PROG RUN/CONT connector, the I/O PORT connector, and the mini-DIN connector. These connectors are connected to the I/O control and mini-DIN control circuit on the A1.

A34 I/O Connector

The A34 I/O connector is the board with five connectors: the GPIB connector, the VIDEO

terminal, the PRINTER port, the 24-BIT I/O PORT, and the LAN port.

A51 GSP

The A51 GSP (graphics system processor) provides an interface between the A1 CPU and the A52 LCD. The A1 CPU converts the formatted data to GSP commands and writes them to the A51 GSP. The A51 GSP processes the data to obtain the necessary signals and sends these signals to the A52 LCD.

The A51 GSP receives two power supply voltages: + 5VD, which is used for data processing and converted to + 3.3 V, and + 15 V, which is passed on the A54 Inverter. The + 3.3 V goes to the A52 LCD.

The A51 also has a 24 bit I/O control circuit, which interfaces the 4294A to an external handler through the A34 I/O connector.

A54 Inverter

The A54 Inverter is located in the LCD module on the front panel assembly. The A54 receives + 15 V from the A51 GSP and provides a high voltage (800 to 1000 VAC) to the backlight of the LCD.

A52 LCD (Liquid Crystal Display)

The A52 LCD is a 8.5 TFT Color LCD, receives a high voltage (800 to 1000 VAC) from the A54 Inverter as backlight power and the digital horizontal and the vertical signals from the A51 GSP.

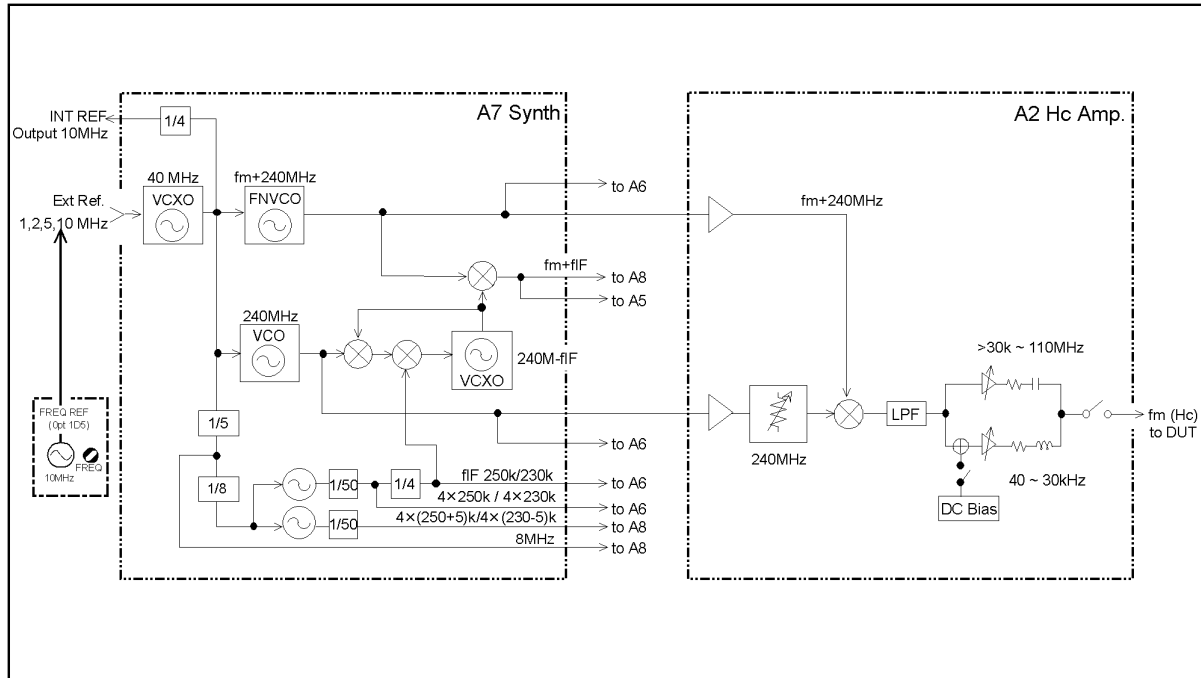
A53 FDD

The 4294A has a built-in, 3-1/2 inch FDD (Flexible Disk Drive) on the front panel. The high density or 2 double density 3-1/2 inch flexible disk is applicable. The A53 FDD reads and writes data to and from the flexible disk.

SOURCE THEORY

The source group generates all analog signals in the 4294A, a phase-locked test signal(f_m) to the device under test, a DC bias signal to the device under test, IF signals for the transducer group and the vector ratio detector group, and a sampling signal for the A-D converter on the vector ratio detector.

Figure 8-4 Source Group Simplified Block Diagram



4294ase08001

The source group consists of the following assemblies:

- A7 Synthesizer
- A2 Hc Amp.
- A60 High Stability Frequency Reference (Option 1D5)

A7 Synthesizer

The A7 synthesizer provides the following signals:

- 240MHz signal : is supplied to the A2 and A6.
- 240MHz + f_m , where f_m is a test frequency of 40Hz to 110MHz: is supplied to the A2 and A6.
- f_{IF} (230kHz/250kHz): is supplied to the A6 through the A20.
- $f_m + f_{IF}$: is supplied to A5 and A8.
- $4f_{IF}$ (4x230kHz/4x250kHz): is supplied to the A6 through the A20.
- $4x(230-5)kHz/4x(250+5)kHz$: is supplied to the A8 through the A20.

- 8MHz (for A/D converter clock): is supplied to the A8 through the A20.
- 10MHz: is routed to the INT REF Output connector on the rear panel.

A2 Hc Amp.

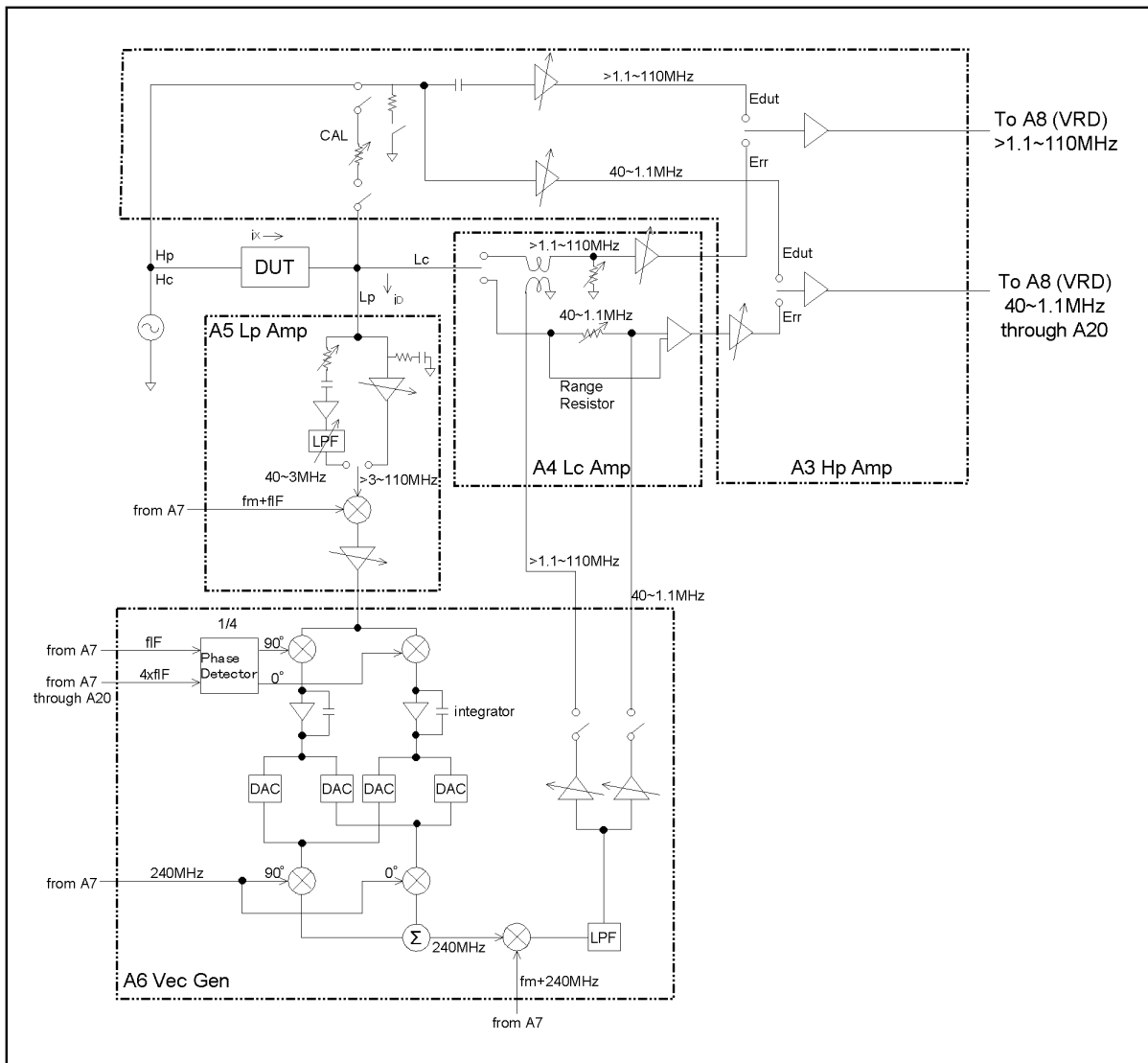
The A2 Hc amp. produces a stable and accurate test signal. This signal is a CW or swept signal between 40 Hz to 110 MHz, with a OSC level from 5 mV to 1Vrms/200 μ A to 20 mArms. The 240 MHz signal from the A7 is applied to the mixer of the A2. It is then converted to the CW or swept signal (40 Hz to 110 MHz) by mixing with the CW or swept local signal (240MHz + fm : 240.00004 MHz to 350 MHz) from the A7.

The A2 Hc amp. has a DC bias source that provides constant bias voltage up to 40 V, and bias current up to 100 mA.

TRANSDUCER THEORY

The transducer group balances the range resistor current with the DUT current to maintain a zero potential at the low terminal(Lp) and transforms the DUT impedance, or admittance, into two AC signals (“Edut” and “Err”).

Figure 8-5 Transducer Group Simplified Block Diagram



4294ase08002

The transducer group consists of the following assemblies:

- A3 Hp Amp.
- A4 Lc Amp.
- A5 IV Converter & Lp Amp.
- A6 Vector Generator

A3 Hp Amp.

The A3 Hp amp. senses the voltage across the DUT (E_{dut}), and transmit the voltage (E_{dut}) to the vector ratio detector. The voltage across the range resistor (E_{rr}) from the A4 Lc amp. is transmitted to the vector ratio detector through the A3 Hp amp.

The A3 Hp amp. also switches these two voltages to transmit to the vector ratio detector.

A4 Lc Amp.

The A4 Lc amp. senses the voltage across the range resistor (E_{rr}), and transmits the voltage to the A3 Hc amp. The A4 Lc amp receives the feedback signal from the A6 vector generator to cancel the current through the DUT. The feedback signal goes through the range resistor.

A5 IV Converter & Lp Amp.

The A5 IV converter & Lp amp detects the unbalanced current “ i_D ”, and converts the “ i_D ” signal into an equal phase IF signal. The IF signal is supplied to the A6 vector generator.

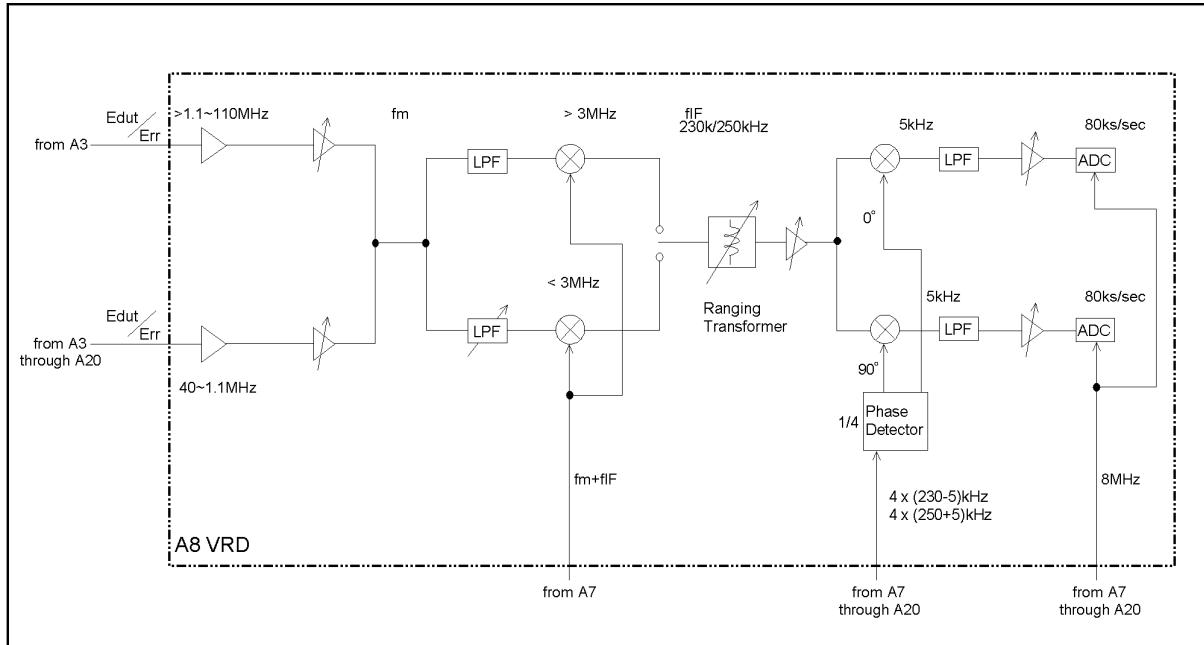
A6 Vector Generator

The A6 vector generator converts the IF signal from the A5 into two DC voltages, proportional to it orthogonal (quadrature, 90 degree phase difference) vector components by the phase detector. The two DC voltages are amplified by integrators and applied to mixers, and are converted to a 240MHz signal which is in phase with the unbalance current by mixing with the 240 MHz from the A7. The 240MHz signal is applied to the next mixer, and is converted to a frequency equal to the unbalanced current frequency by mixing with the 240 MHz + f_m from the A7. The frequency signal is applied to the A4.

VECTOR RATIO DETECTOR THEORY

The A8 board is the vector ratio detector. The vector ratio detector converts the AC voltages from the transducer group into digital data.

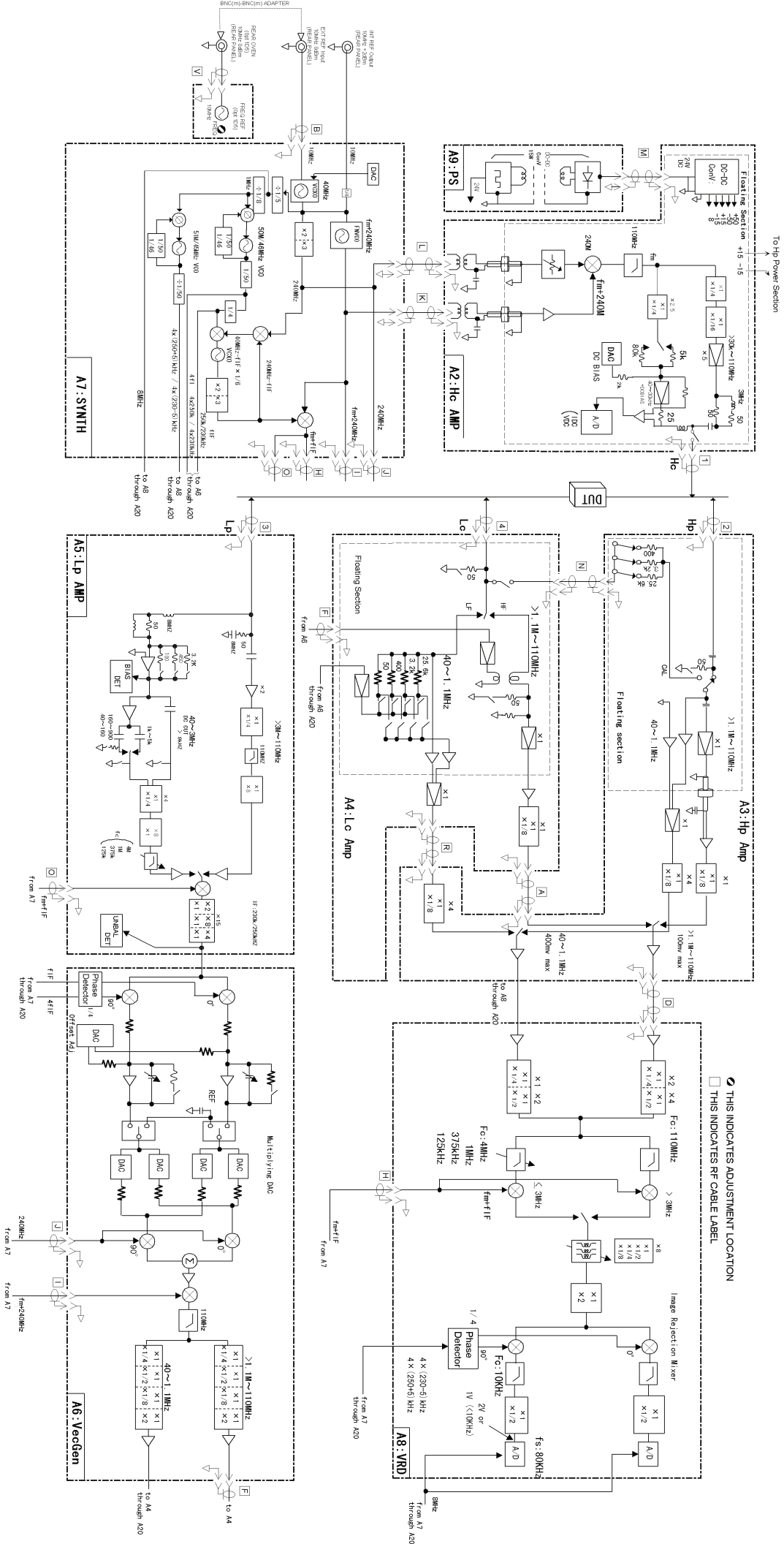
Figure 8-6 Vector Ratio Detector Group Simplified Block Diagram



A8 Vector Ratio Detector

The A8 vector ratio detector converts the “Edut” or “Err” signal from the A3 into an equal phase IF signal by mixing with the $f_m + f_{IF}$ signal from the A7. The IF signal is converted into two 5 kHz signals proportional to its orthogonal vector components. The A-D Converter converts the 5 kHz signal into digital data.

To Hrp Power Section



9

Parts Replacement

This chapter contains the 4294A's replaceable parts list and the procedure to replace its assemblies.

Replaceable Part List

Ordering Information

To order part listed in the replaceable part lists, quote the Agilent Technologies part number (with a check digit), indicate the quantity required, and address the order to the nearest Agilent Technologies office. The check digit will ensure accurate and timely processing of the order.

To order a part not listed in the replaceable part table, include the instrument model number, the description and function of the part, and the quantity of parts required. Address the order to the nearest Agilent Technologies.

Direct Mail Order System

Within the USA, Agilent Technologies can supply parts through a direct mail order system. There are several advantages to this system:

- Direct ordering and shipping from the Agilent Technologies Parts Center in Mountain View, California.
- No maximum or minimum on any mail order (there is a minimum order amount for parts ordered through a local Agilent Technologies office when the orders require billing and invoicing)
- Prepaid transportation (there is a small handling charge for each order).
- No invoices.

In order for Agilent Technologies to provide these advantages, please send a check or money order with each order.

Mail order forms and specific ordering information are available through your local Agilent Technologies sales office. Addresses and telephone numbers are located in a separate document shipped with the manuals.

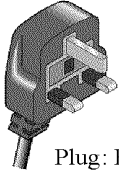
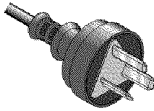
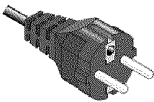
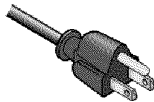


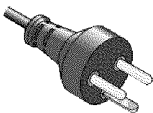
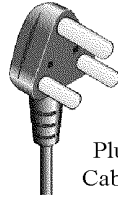
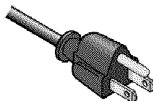
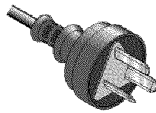
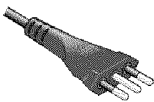
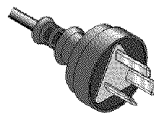
Exchange Assemblies

Under the rebuilt-exchange assembly program, certain factory-repaired and tested assemblies are available on a trade-in basis. These assemblies are offered at lower cost than a new assembly, but meet all factory specifications required of a new assembly.

The defective assembly must be returned for credit under the terms of the rebuilt-exchange assembly program. Any spare assembly stock desired should be ordered using the new assembly part number.

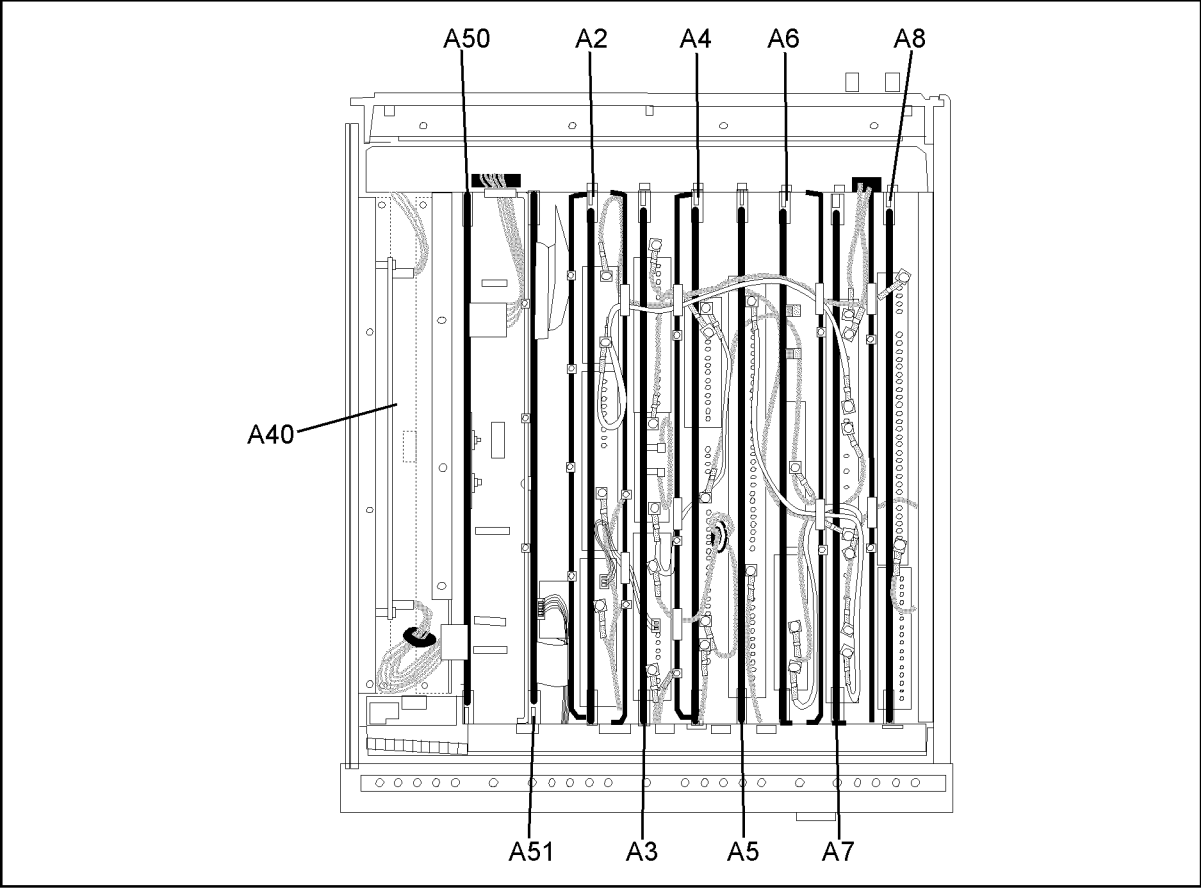
Parts List

Figure 9-1 Power Cables and Plug Configurations

<p>OPTION 900</p>  <p>United Kingdom</p> <p>Plug: BS 1363/A, 250V, 10A Cable: 8120-1351, 8120-8705</p>	<p>OPTION 901</p>  <p>Australia/New Zealand</p> <p>Plug: AS 3112, 250V, 10A Cable: 8120-1369</p>
<p>OPTION 902</p>  <p>Continental Europe</p> <p>Plug: CEE 7 Standard Sheet VII, 250V, 10A Cable: 8120-1689</p>	<p>OPTION 903</p>  <p>U.S./Canada</p> <p>Plug: NEMA 5-15P, 125V, 10A Cable: 8120-1378</p>
<p>OPTION 904</p>  <p>U.S./Canada</p> <p>Plug: NEMA 6-15P, 250V, 6A Cable: 8120-0698</p>	<p>OPTION 906</p>  <p>Switzerland</p> <p>Plug: SEV Type 12, 250V, 10A Cable: 8120-2104</p>
<p>OPTION 912</p>  <p>Denmark</p> <p>Plug: SR 107-2-D, 250V, 10A Cable: 8120-2956</p>	<p>OPTION 917</p>  <p>India/Republic of S. Africa</p> <p>Plug: IEC 83-B1, 250V, 10A Cable: 8120-4211</p>
<p>OPTION 918</p>  <p>Japan</p> <p>Plug: JIS C 8303, 125V, 12A Cable: 8120-4753</p>	<p>OPTION 920</p>  <p>Argentina</p> <p>Plug: Argentine Resolution 63, Annex IV, 250V, 10A Cable: 8120-6870</p>
<p>OPTION 921</p>  <p>Chile</p> <p>Plug: CEI 23-16, 250V, 10A Cable: 8120-6978</p>	<p>OPTION 922</p>  <p>China</p> <p>Plug: GB 1002, 250V, 10A Cable: 8120-8376</p>
<p>NOTE: Each option number includes a 'family' of cords and connectors of various materials and plug body configurations (straight, 90° etc.).</p>	

power_e

Figure 9-2 Top View (Major Assemblies)

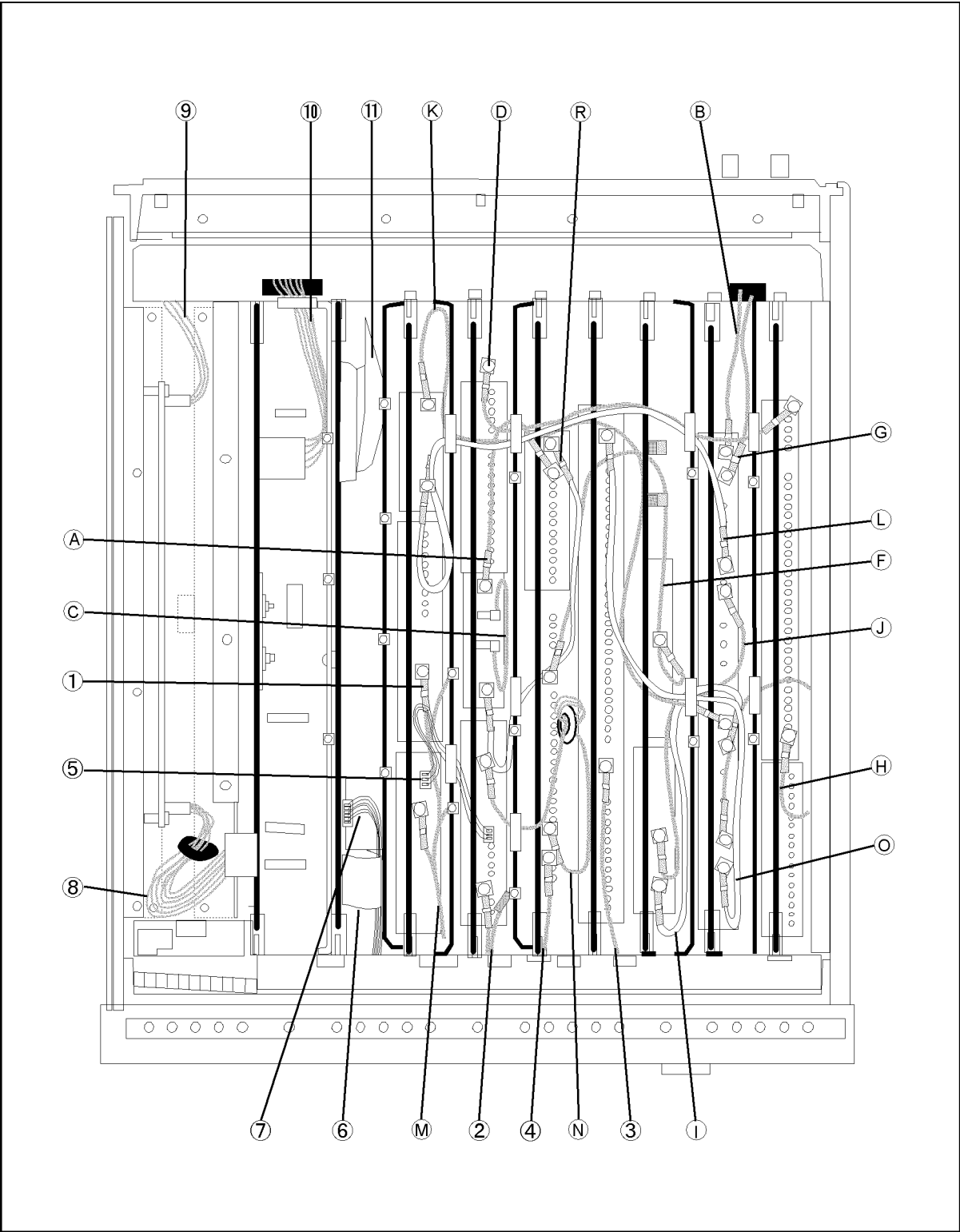


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Table 9-1 Top View (Major Assemblies)

Reference Designation	Agilent Part Number	Check Digit	Qty.	Description
A2	04294-66502	3	1	High Current
	04294-69502	9	1	High Current (rebuilt-exchange)
A3	04294-66503	4	1	Hp Amplifier.
	04294-69503	0	1	Hp Amplifier. (rebuilt-exchange)
A4	04294-66504	5	1	Lc Amplifier.
	04294-69504	1	1	Lc Amplifier. (rebuilt-exchange)
A5	04294-66505	6	1	IV Converter & Lp AMP
	04294-69505	2	1	IV Converter & Lp AMP (rebuilt-exchange)
A6	04294-66506	7	1	Vector Generator
A7	04294-66507	8	1	Synthesizer
	04294-69507	4	1	Synthesizer (rebuilt-exchange)
A8	04294-66508	9	1	Vector Ratio Detector
	04294-69508	5	1	Vector Ratio Detector (rebuilt-exchange)
A50	04294-66550	1	1	DC/DC Convertor
A51	E4970-66553	0	1	GSP
A40	0950-3246	7	1	Preregulator

Figure 9-3 Top View (Cables and Wires)

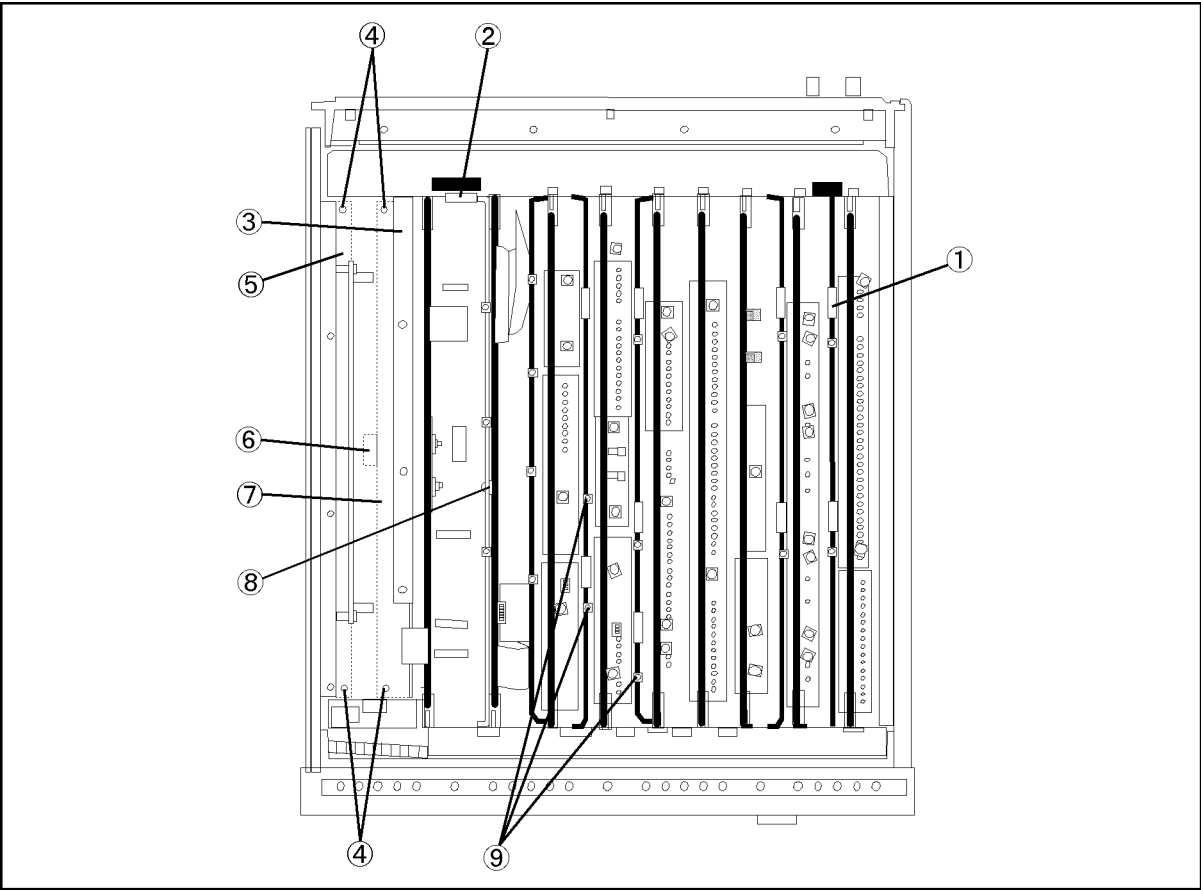


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Table 9-2 Top View (Cables and Wires)

Reference Designation	Agilent Part Number	Check Digit	Qty.	Description
A	04294-61601	3	1	RF Cable “A”, A3 to A4
B	04396-61640	3	1	RF Cable “B”, A7 to EXT REF Input
C	04294-61602	4	1	RF Cable “C”, A3 to A3
D	04294-61603	5	1	RF Cable “D”, A3 to A8
F	04294-61604	6	1	RF Cable “F”, A4 to A6
G	04396-61639	0	1	RF Cable “G”, A7 to INT REF Output
H	04294-61605	7	1	RF Cable “H”, A7 to A8
I	E5000-61609	6	1	RF Cable “I”, A7 to A8
J	E5000-61610	9	1	RF Cable “J”, A6 to A7
K	04294-61621	7	1	RF Cable “K”, A2 to A7
L	04294-61622	8	1	RF Cable “L”, A2 to A7
M	04294-61619	3	1	RF Cable “M”, A2 to A9
	0515-1550	0	1	Screw M3-L 8
N	04294-61612	6	1	RF Cable “N”, A3 to A4
O	E4970-61624	6	1	RF Cable “O”, A5 to A7
R	E4970-61626	8	1	RF Cable “R”, A3 to A4
1	See Table 9-5		1	RF Cable “1”(part of 4TP Assembly)
	0515-1550	0	1	Screw M3-L 8
2	See Table 9-5		1	RF Cable “2”(part of 4TP Assembly)
	0515-1550	0	1	Screw M3-L 8
3	See Table 9-5		1	RF Cable “3”, (part of 4TP Assembly)
4	See Table 9-5		1	RF Cable “4”, (part of 4TP Assembly)
5	04294-61641	1	1	Wire, A2 to A3
6	See Table 9-14	9	1	Flat Cable FFC, to LCD
7	See Table 9-11	6	1	Cable, to LCD
8	04294-61672	8	1	Cable, Power Supply to A50
9	04294-61671	7	1	Power Switch Cable Assembly
10	04294-61656	7	1	Cable PRI, to A1
11	04294-61654	6	1	Flat Cable, to A1

Figure 9-4 Top View (Miscellaneous Parts)

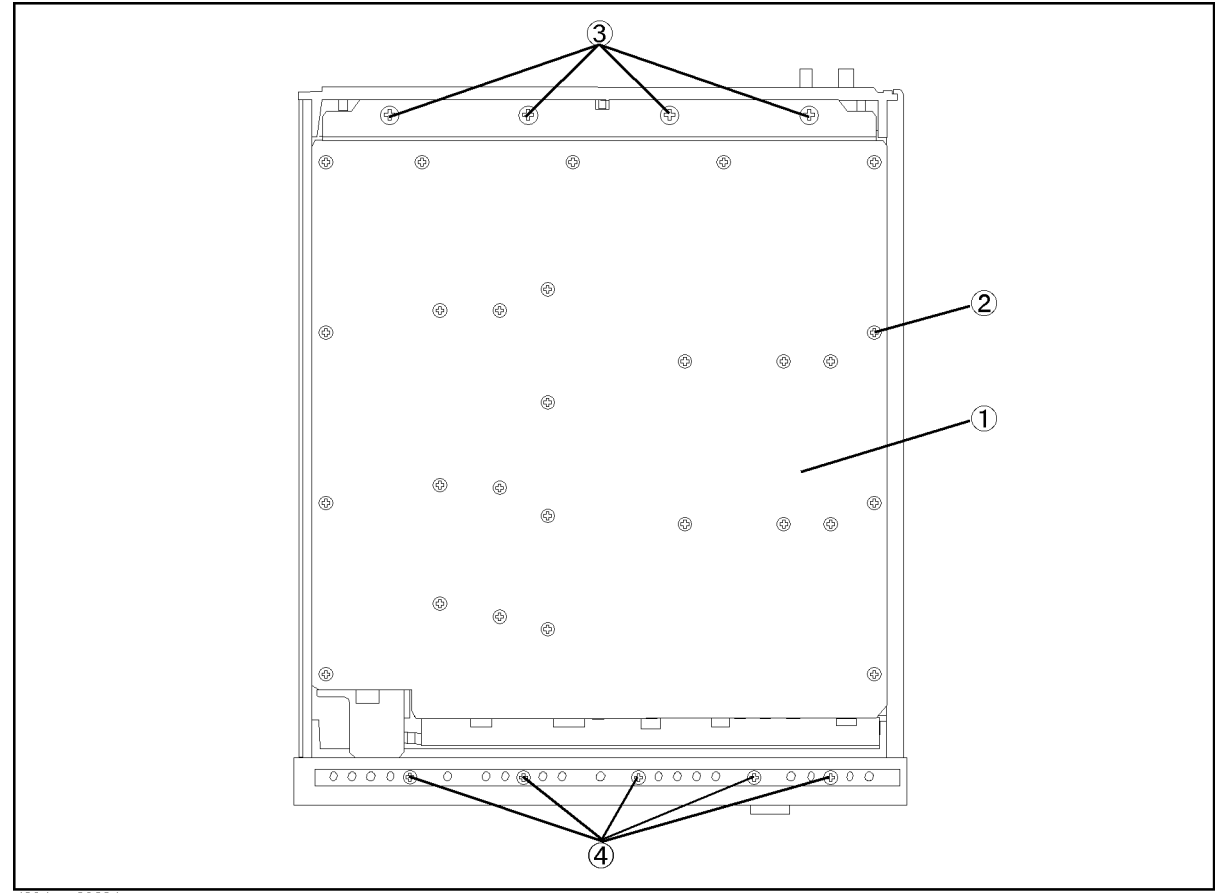


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Table 9-3 Top View (Miscellaneous Parts)

Reference Designation	Agilent Part Number	Check Digit	Qty.	Description
1	1400-1048	9	10	Edge Saddle
2	1400-2198	2	1	Edge Saddle
3	04294-00110	1	1	Slide Shield
	0363-0170	5	86 cm	RFI Gasket
4	0515-1719	3	4	Screw M4X10
5	04294-00114	5	1	Plate
6	1400-1334	6	3	Cable Clamp
7	04294-00113	4	1	Plate
8	0403-0026	6	1	Plug Hole
9	0515-1550	0	3	Screw M3-L8

Figure 9-5 Top View (Shield)

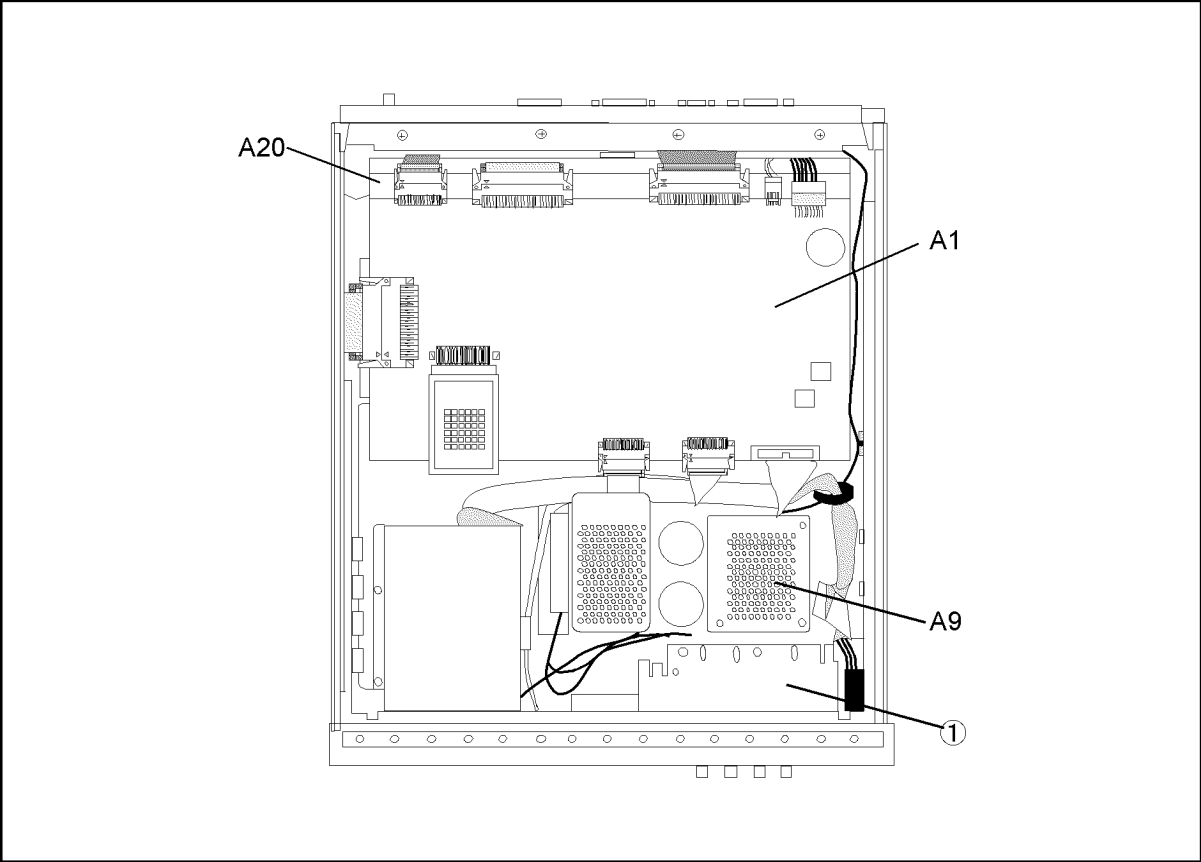


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Table 9-4 Top View (Shield)

Reference Designation	Agilent Part Number	Check Digit	Qty.	Description
1	04294-00601	5	1	Top Shield
2	0515-0914	8	27	Screw-Mach M3X0.5
3	0515-1719	3	4	Screw M4X10
4	0515-0889	6	5	Screw M3.5

Figure 9-6 **Bottom View (Major Assemblies)**

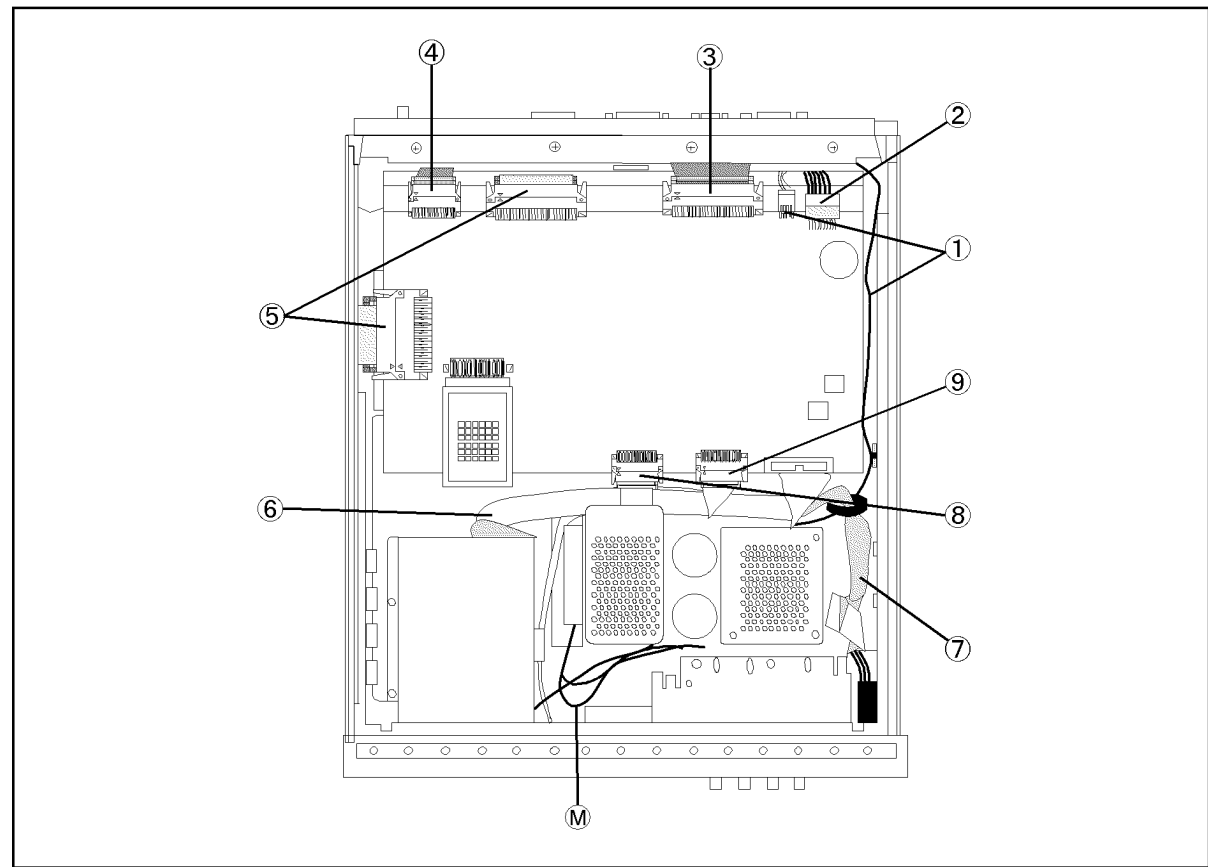


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Table 9-5 **Bottom View (Major Assembly)**

Reference Designation	Agilent Part Number	Check Digit	Qty.	Description
A1	04294-66501	2	1	A1 CPU Board
A9	04294-66509	0	1	A9 Floating Power Supply
A20	04294-66520	5	1	Mother Board (Under the A1 board)
1	04294-64903	4	1	4TP Assembly

Figure 9-7 Bottom View (Cables and Wires)

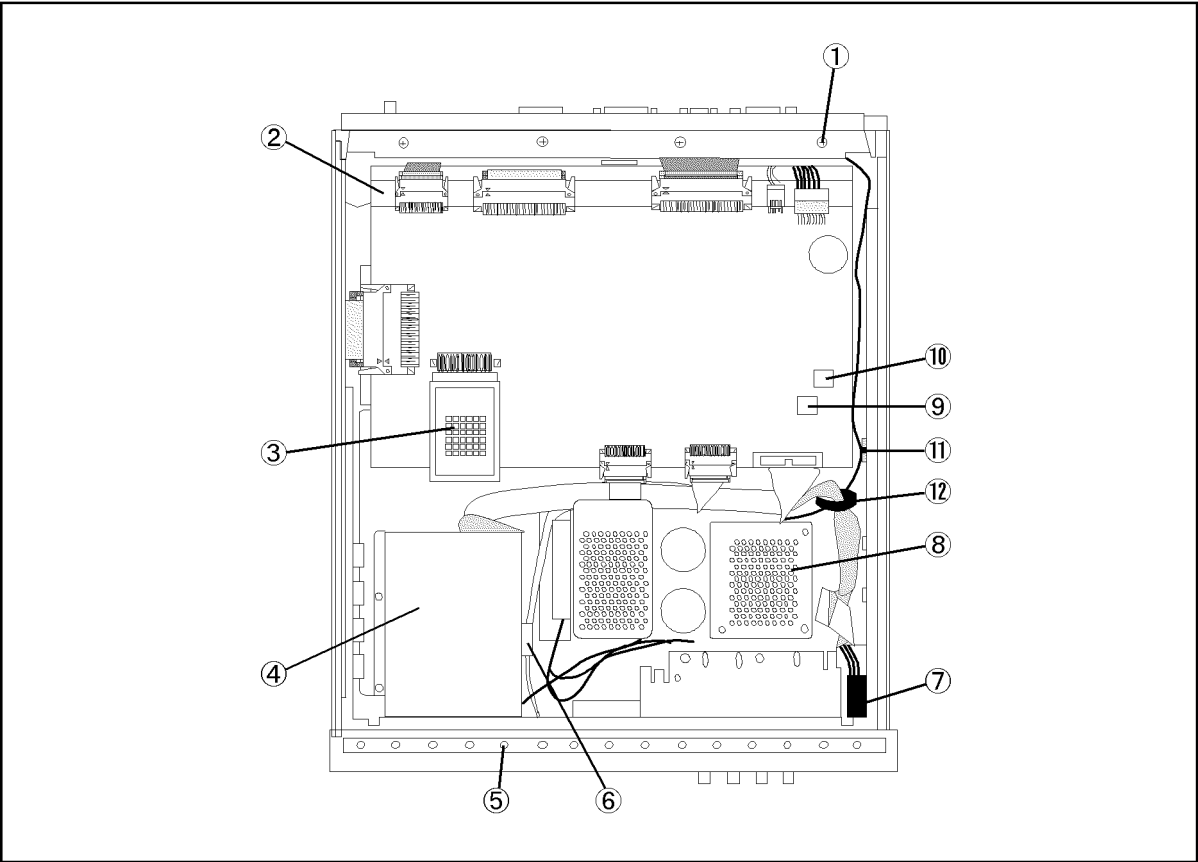


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Table 9-6 Bottom View (Cables and Wires)

Reference Designation	Agilent Part Number	Check Digit	Qty.	Description
1	04294-61642	2	1	Wire
2	Refer to Table 9-3		1	Cable PRI
3	Refer to Table 9-3		1	Flat Cable (to A51)
4	04396-61663	0	1	Flat Cable 40pins
5	04396-61661	8	2	Flat Cable 100pins
6	04294-61651	3	1	Flat Cable
7	04294-61655	7	1	Flat Cable
8	04294-61652	4	1	Flat Cable
9	04396-61662	9	1	Flat Cable

Figure 9-8 Bottom View (Miscellaneous Parts)

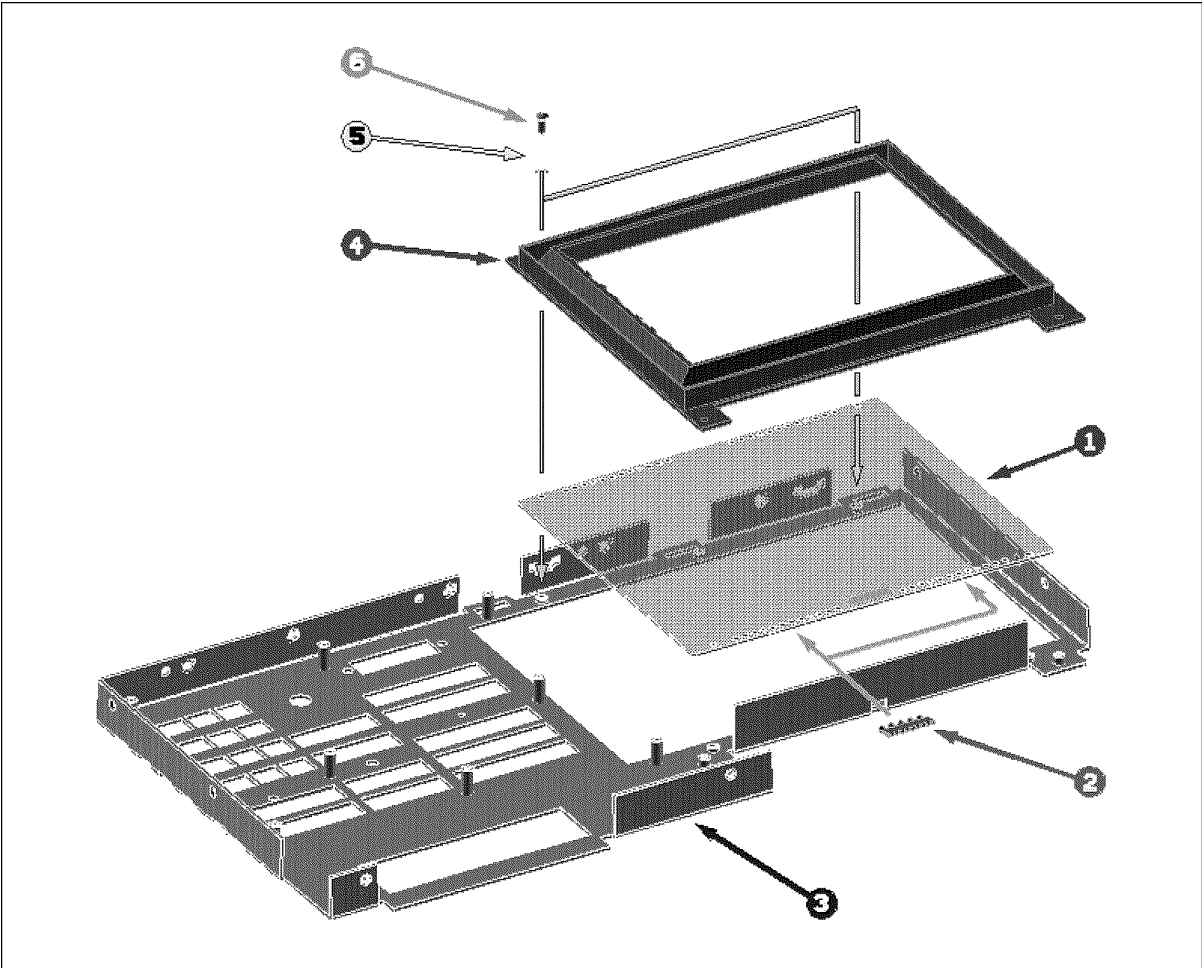


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Table 9-7 Bottom View (Miscellaneous Parts)

Reference Designation	Agilent Part Number	Check Digit	Qty.	Description
1	0515-1719	3	4	Screw M4
2	0515-1550	0	12	Screw M3-L 8 (for A20)
	04294-00111	2	1	Deck
	0515-0914	8	4	Screw-Mach M3X0.5 (for deck)
	0515-1550	0	12	Screw M3-L 8 P-H (for A1)
3	5183-4131	0	1	IC Flash
4	0950-3334	4	1	A53 FDD 3.5
	04294-01275	1	1	Holder
	04396-25004	7	1	Sponge
	0515-0924	0	4	Screw-Mach M3X0.5
	0535-0031	2	4	Nut-Hex w/locker
5	0515-0889	6	4	Screw M3.5
6	1400-0611	0	1	Cable Clamp
7	See Table 9-2		1	Power Switch Cable Assembly
	04294-01203	3	1	Angle
	See Table 9-17		1	Key Cap
	0515-0914	8	2	Screw-Mach M3X0.5
8	04294-00604	8	1	Case Shield
	0515-1550	0	8	Screw M3-L 8 P-H
9	5188-1386	1	1	IC EEPROM
10	04294-85101	7	1	Boot ROM
11	1400-1334	6	1	Cable Clamp
12	1400-1391	5	1	Cable Clamp

Figure 9-9 Front Assembly 1

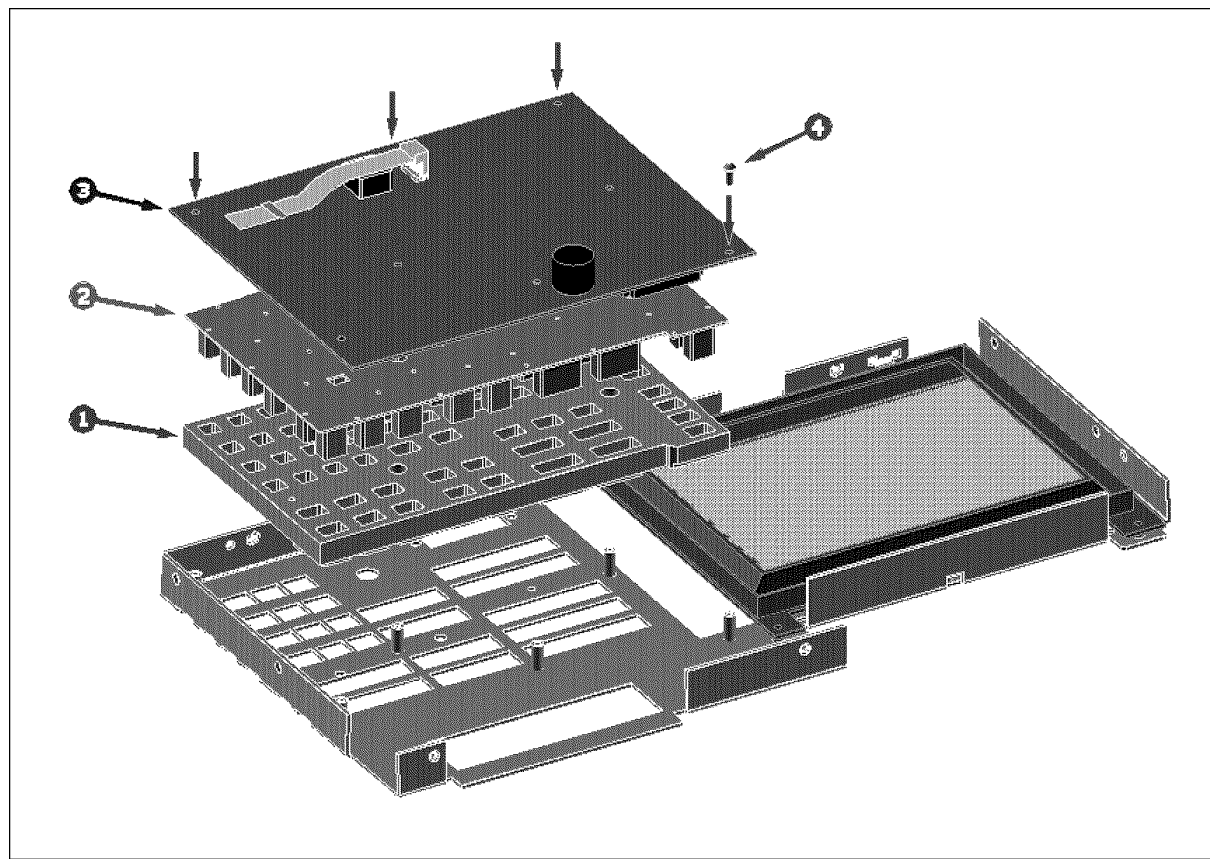


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Table 9-8 Front Assembly 1

Reference Designation	Agilent Part Number	Check Digit	Qty.	Description
1	04294-25011	1	1	Optical filter
2	8160-0989	2	6 cm × 2	Shield Gasket
3	04294-00202	2	1	Sub Panel
4	04396-40071	0	1	Bezel
5	3050-0891	7	2	Washer M3
6	0515-1550	0	2	Screw M3-L 8 P-H

Figure 9-10 Front Assembly 2

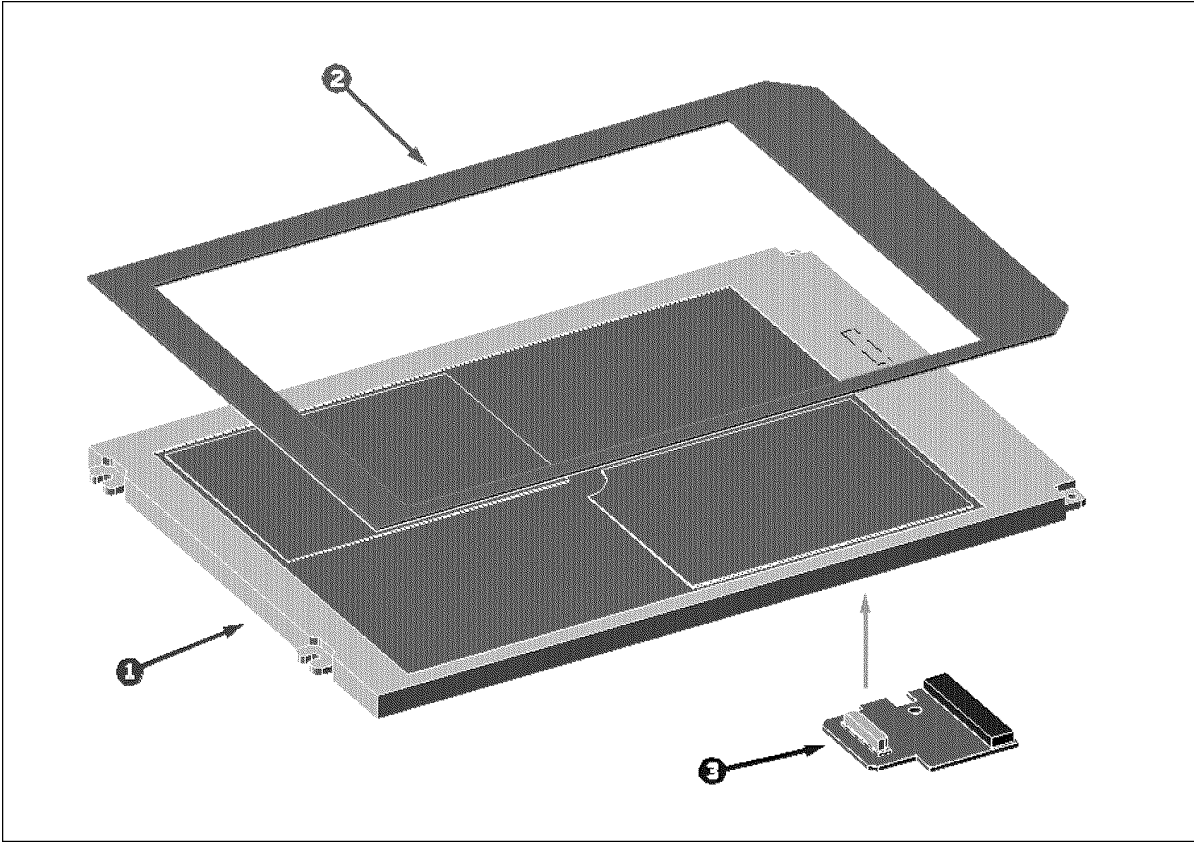


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Table 9-9 Front Assembly 2

Reference Designation	Agilent Part Number	Check Digit	Qty.	Description
1	04396-40003	8	1	Guide
2	04294-25052	2	1	Keypad Rubber
3	04294-66530	7	1	A30 Front Keyboard
4	0515-1550	0	8	Screw M3-L 8 P-H

Figure 9-11 Front Assembly 3

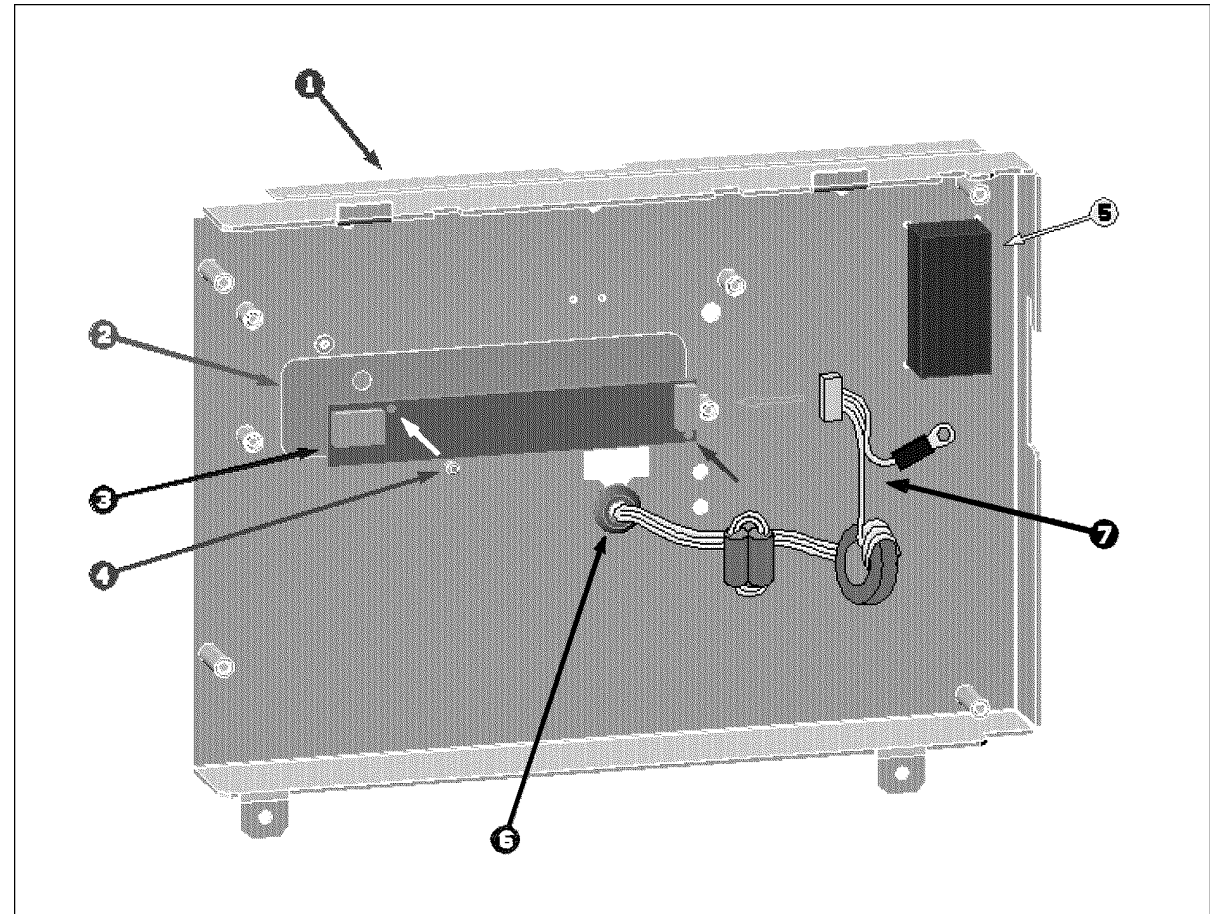


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Table 9-10 Front Assembly 3

Reference Designation	Agilent Part Number	Check Digit	Qty.	Description
1	2090-0361	6	1	A52 LCD 8.5 inch
2	04396-25071	8	1	Gasket
3	E4970-66540	5	1	LCD Mini Board

Figure 9-12 Front Assembly 4

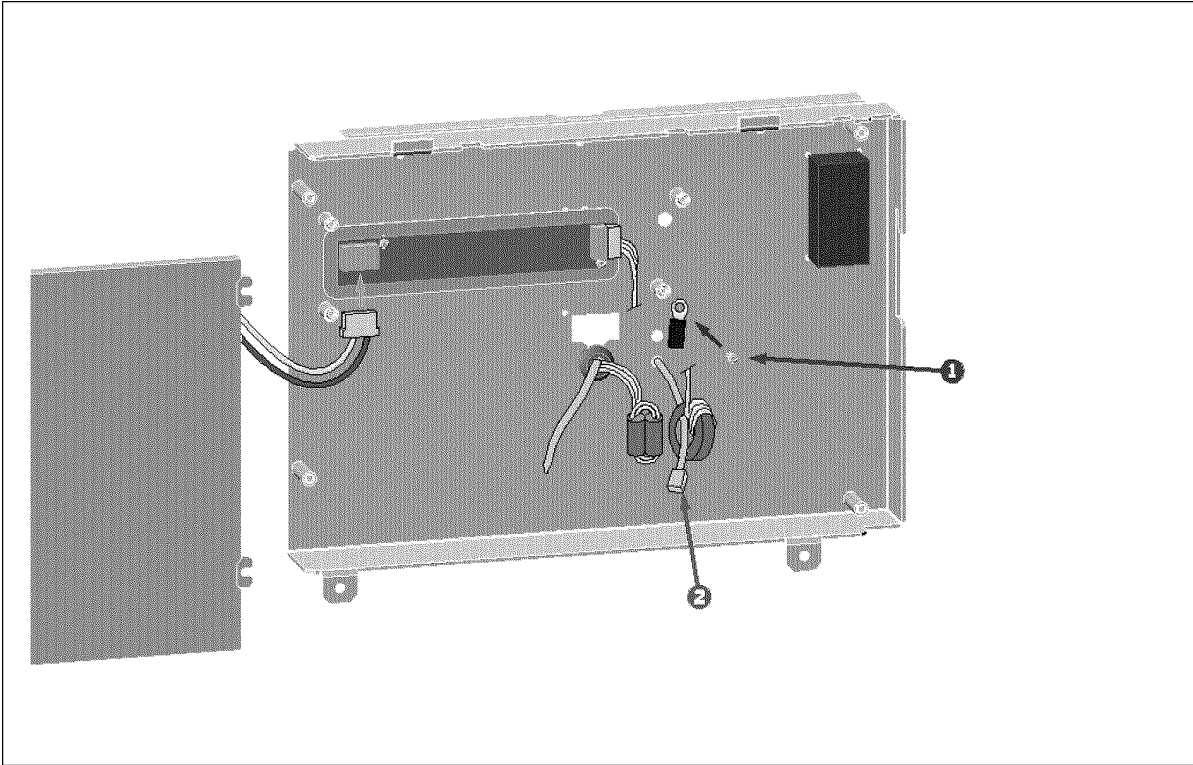


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Table 9-11 Front Assembly 4

Reference Designation	Agilent Part Number	Check Digit	Qty.	Description
1	04294-04011	7	1	Cover
2	04352-25002	8	1	Insulator
3	0950-2924	6	1	A54 Inverter
4	0515-0977	3	2	Screw-Mach M2X0.4
5	E4970-25003	9	1	Sponge
6	0400-0010	2	1	Grommet
7	04294-61623	6	1	Cable

Figure 9-13 Front Assembly 5

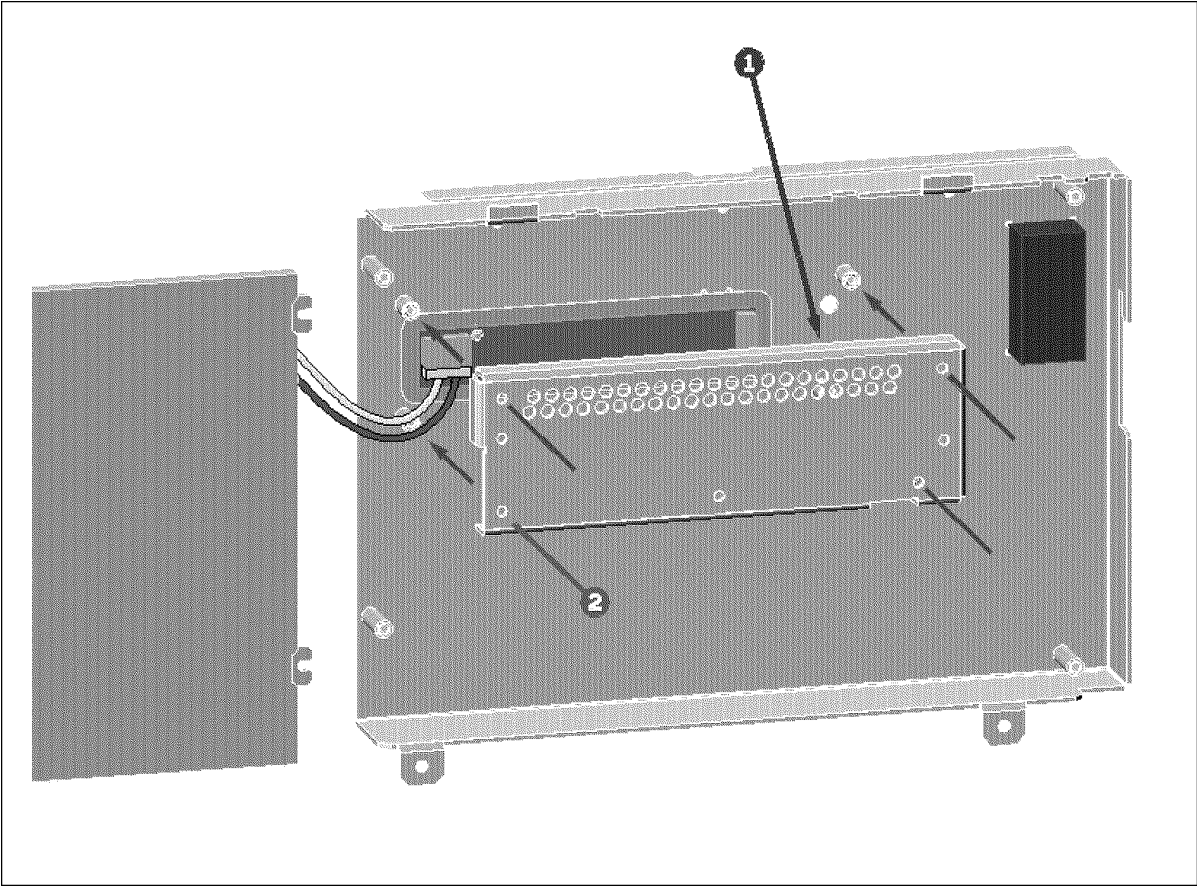


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Table 9-12 Front Assembly 5

Reference Designation	Agilent Part Number	Check Digit	Qty.	Description
1	0515-0924	0	1	Screw-MACH M3X0.5
2	1400-0249	0	1	Cable tie

Figure 9-14 Front Assembly 6

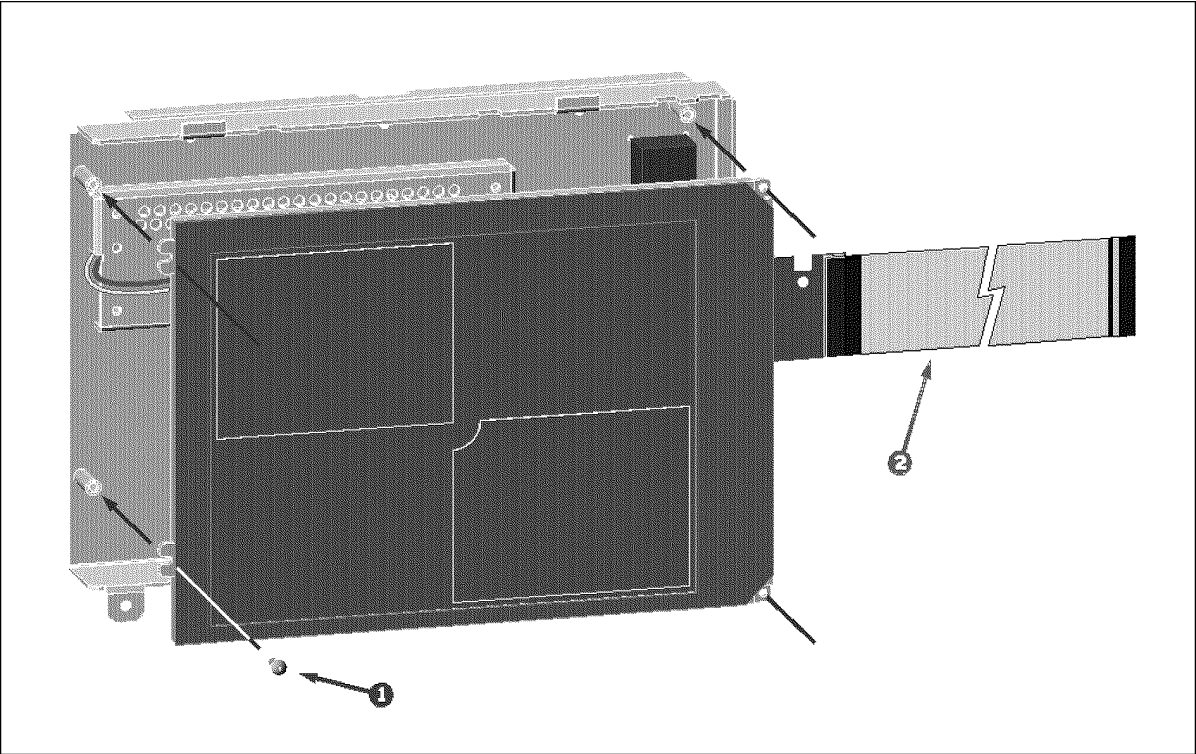


4294ase09013

Table 9-13 Front Assembly 6

Reference Designation	Agilent Part Number	Check Digit	Qty.	Description
1	04294-00607	7	1	Case Shield
2	0515-0914	9	4	Screw-Mach M3X0.5

Figure 9-15 Front Assembly 7

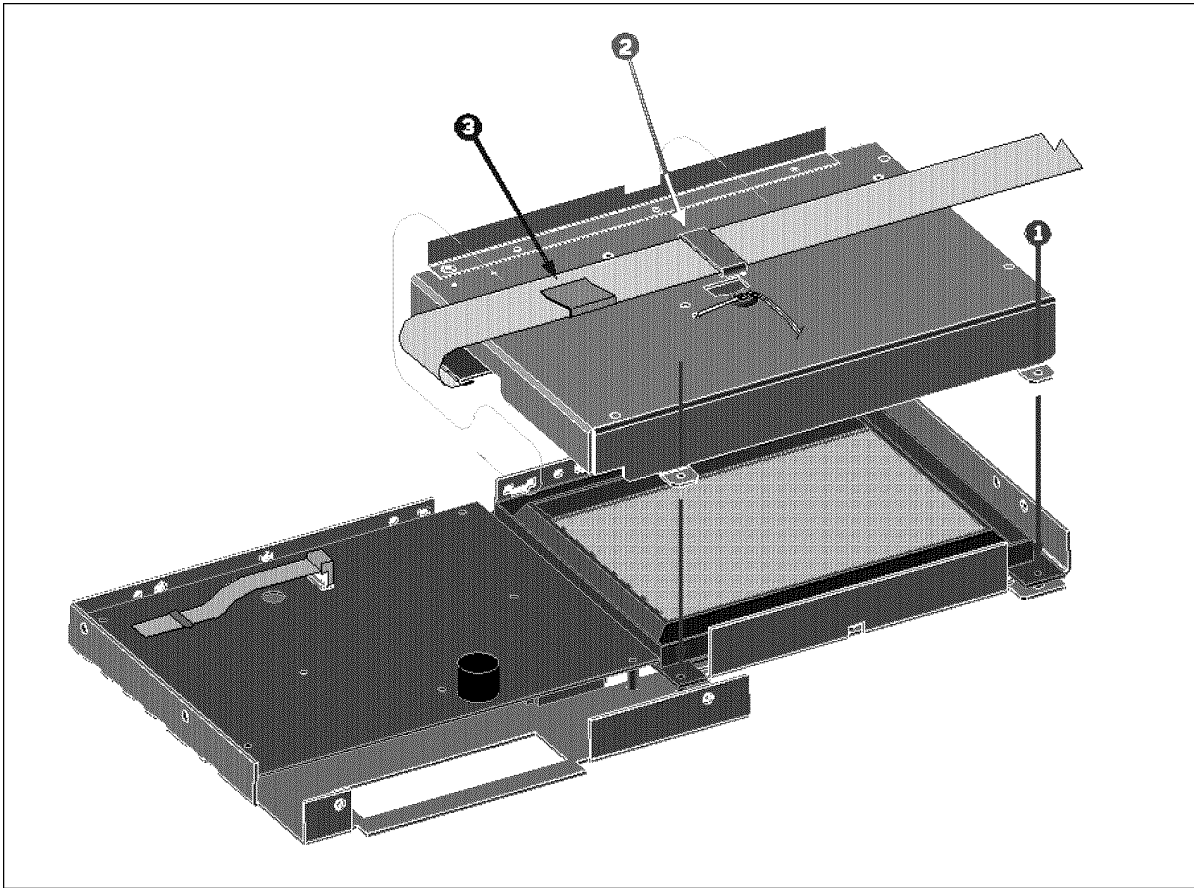


4294ase09014

Table 9-14 Front Assembly 7

Reference Designation	Agilent Part Number	Check Digit	Qty.	Description
1	0515-1550	0	4	Screw M3-L 8 P-H
2	E4970-61651	9	1	Flat Cable

Figure 9-16 Front Assembly 8

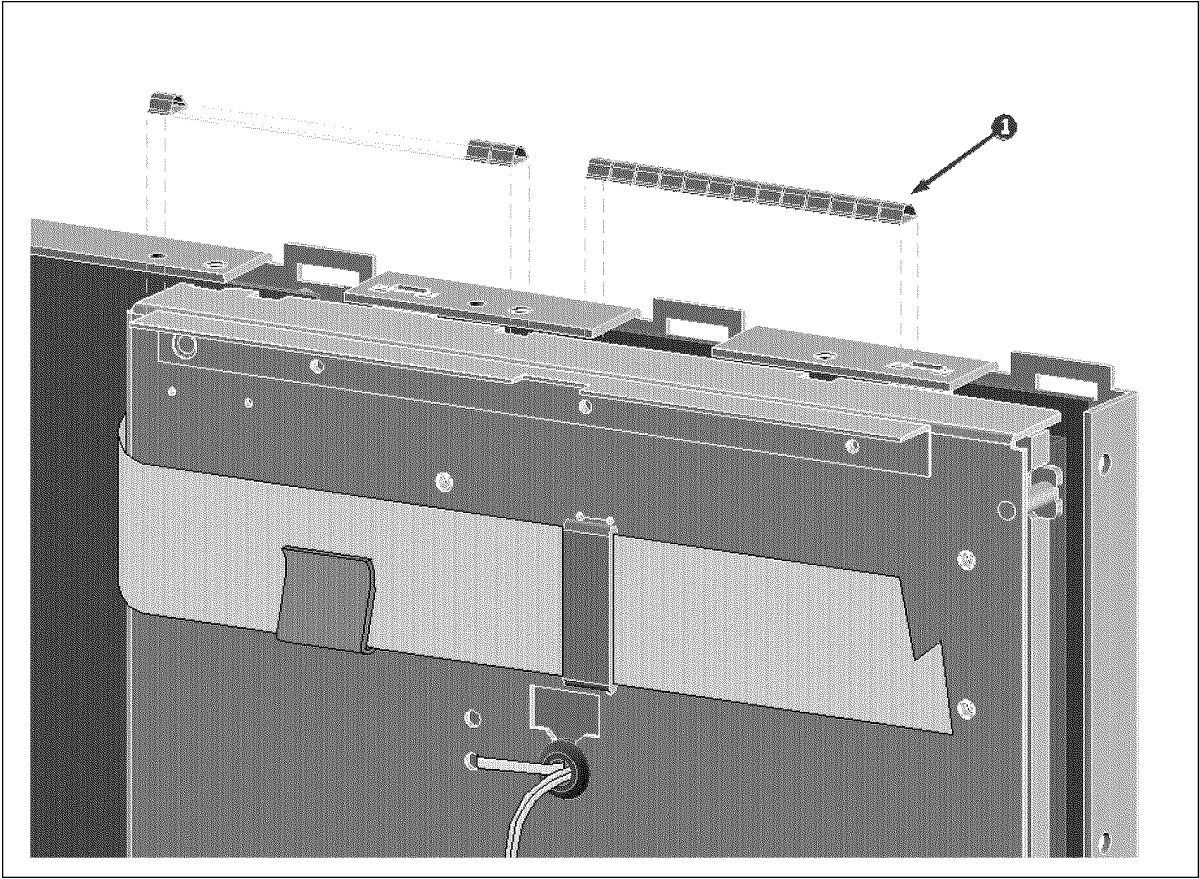


4294ase09015

Table 9-15 Front Assembly 8

Reference Designation	Agilent Part Number	Check Digit	Qty.	Description
1	0515-0907	9	2	Screw-MACH M3X0.5
2	9170-1794	1	1	Magnetic Core
3	1400-0611	0	1	Cable Clamp

Figure 9-17 Front Assembly 9

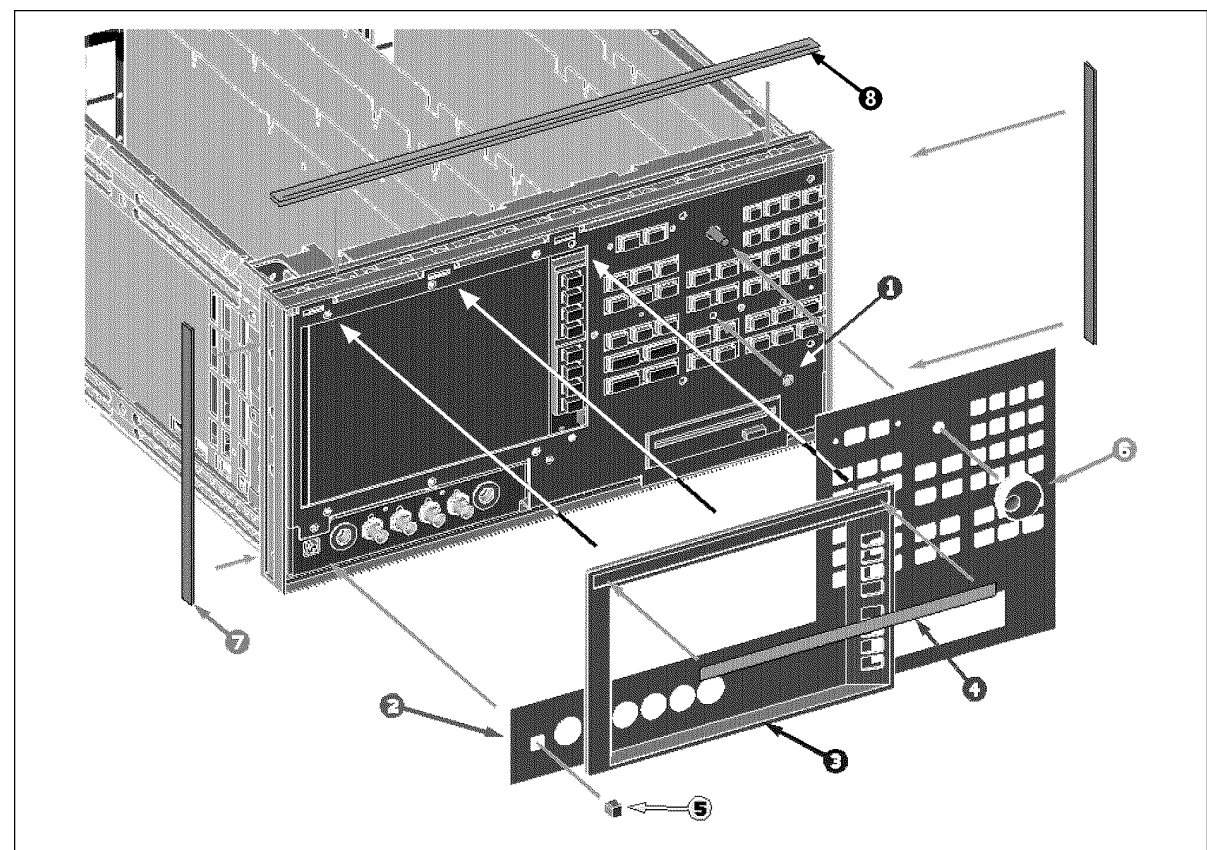


4294ase09016

Table 9-16 Front Assembly 9

Reference Designation	Agilent Part Number	Check Digit	Qty.	Description
1	0363-0170	5	44 cm	RFI Gasket

Figure 9-18 Front Assembly 10

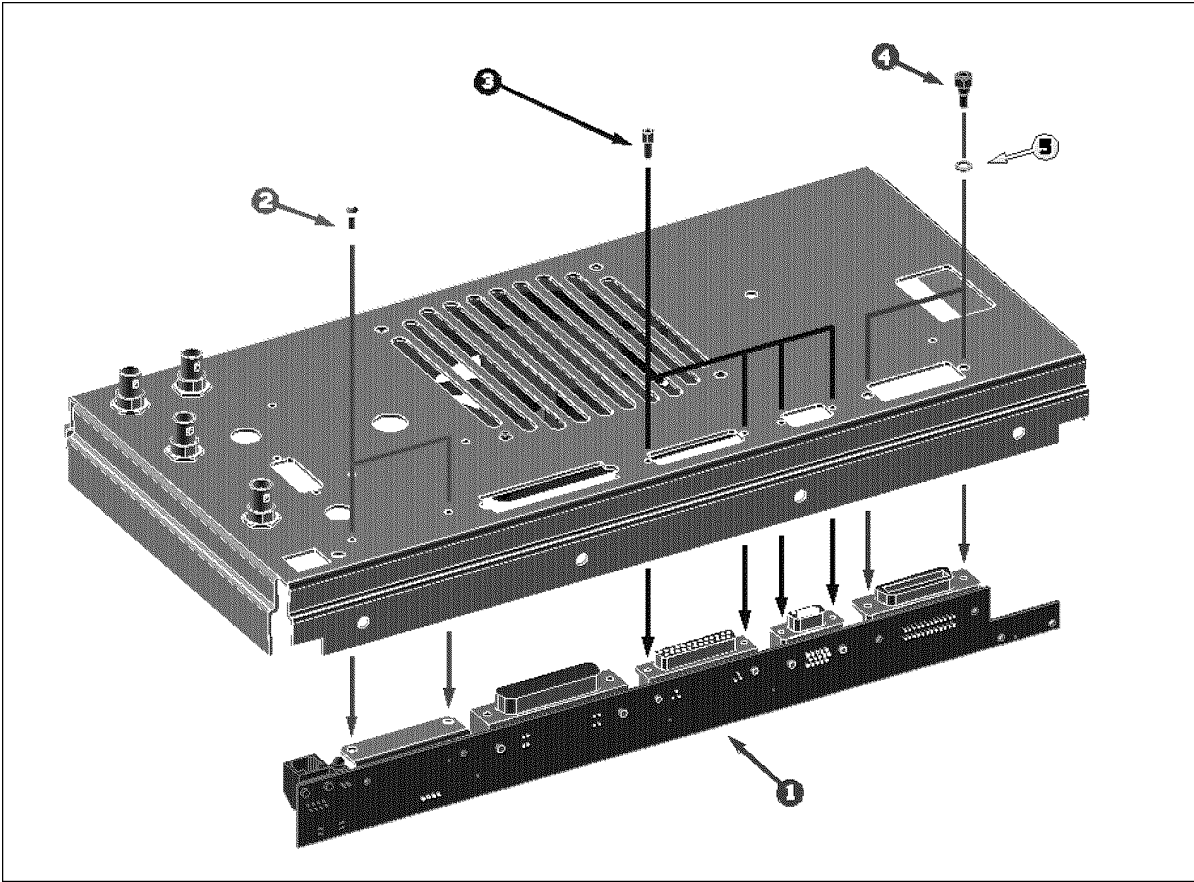


4294ase09017

Table 9-17 Front Assembly 10

Reference Designation	Agilent Part Number	Check Digit	Qty.	Description
1	04191-08000	0	1	Spring
2	04294-00201	1	1	Front Panel
3	04396-40051	6	1	Bezel
4	04294-87101	2	1	Label 4294A
5	5041-0564	4	1	Key Cap
6	5182-7522	6	1	Knob
7	5041-9173	9	2	Side Trim
8	5041-9176	2	1	Trim Strut

Figure 9-19 Rear Assembly 1

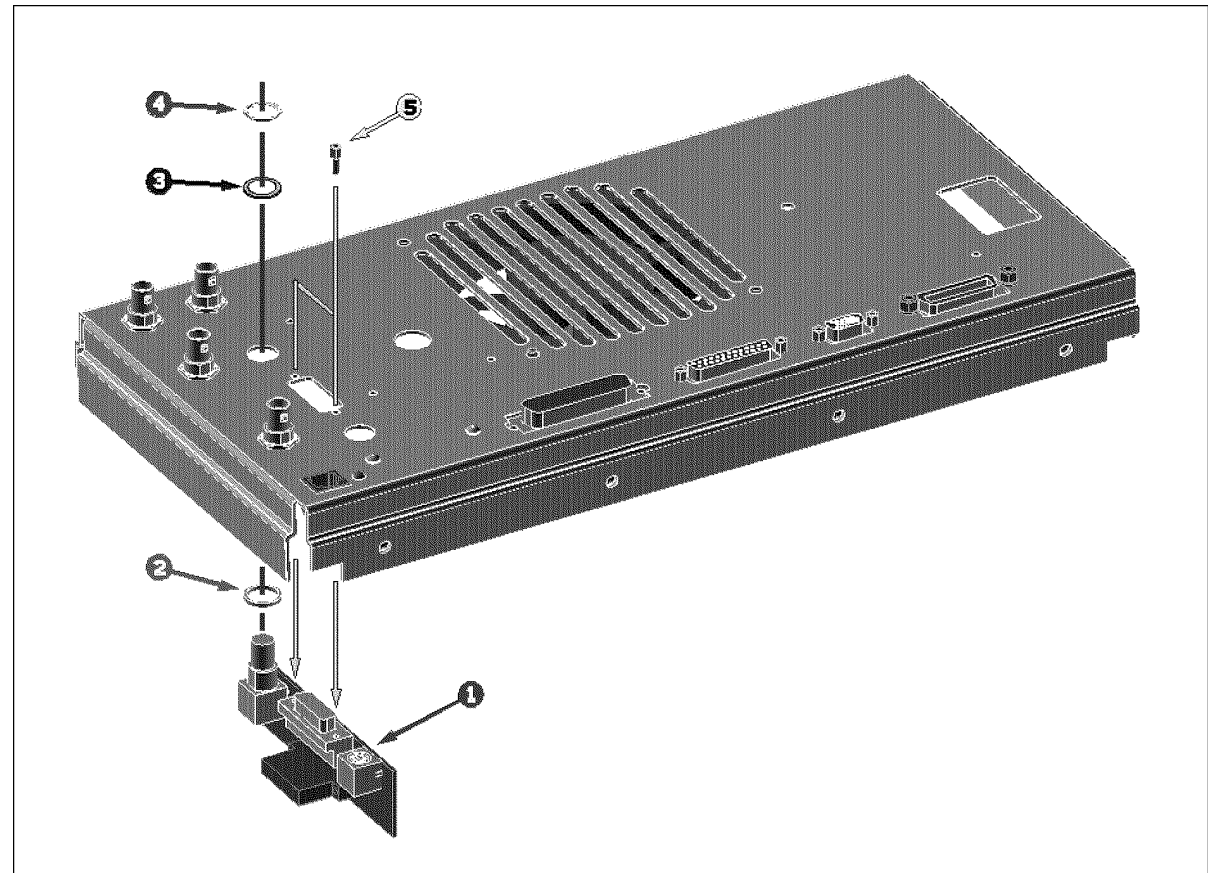


4294ase09018

Table 9-18 Rear Assembly 1

Reference Designation	Agilent Part Number	Check Digit	Qty.	Description
1	04294-66534	1	1	A34 Ext IO
2	0515-1550	0	2	Screw M3-L 8 P-H
3	1251-7812	0	4	Jackscrew
4	0380-0644	4	2	Standoff
5	2190-0577	1	2	Washer

Figure 9-20 Rear Assembly 2



4294ase09019

Table 9-19 Rear Assembly 2

Reference Designation	Agilent Part Number	Check Digit	Qty.	Description
1	E4970-66532	5	1	A32 I-BASIC_IO
2	3050-1546	1	1	Washer
3	2190-0054	9	1	Washer
4	2950-0054	1	1	Nut
5	1251-7812	0	2	Jackscrew

Parts Replacement

Replaceable Part List

Figure 9-21 **Rear Assembly 3**

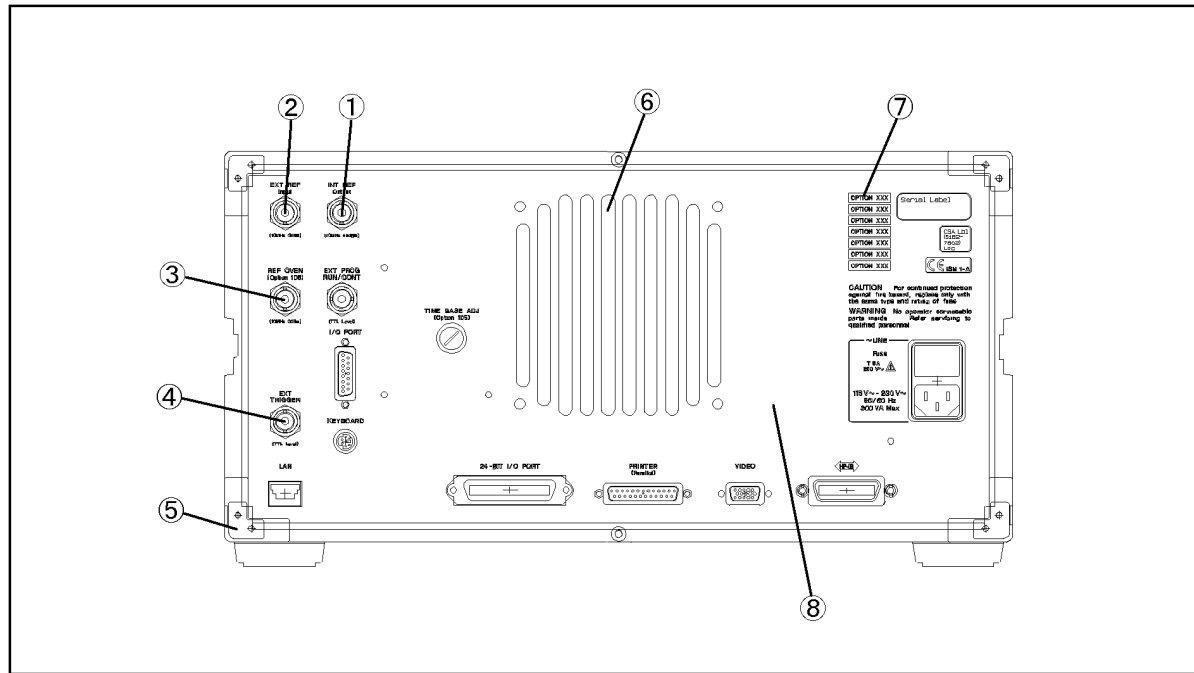
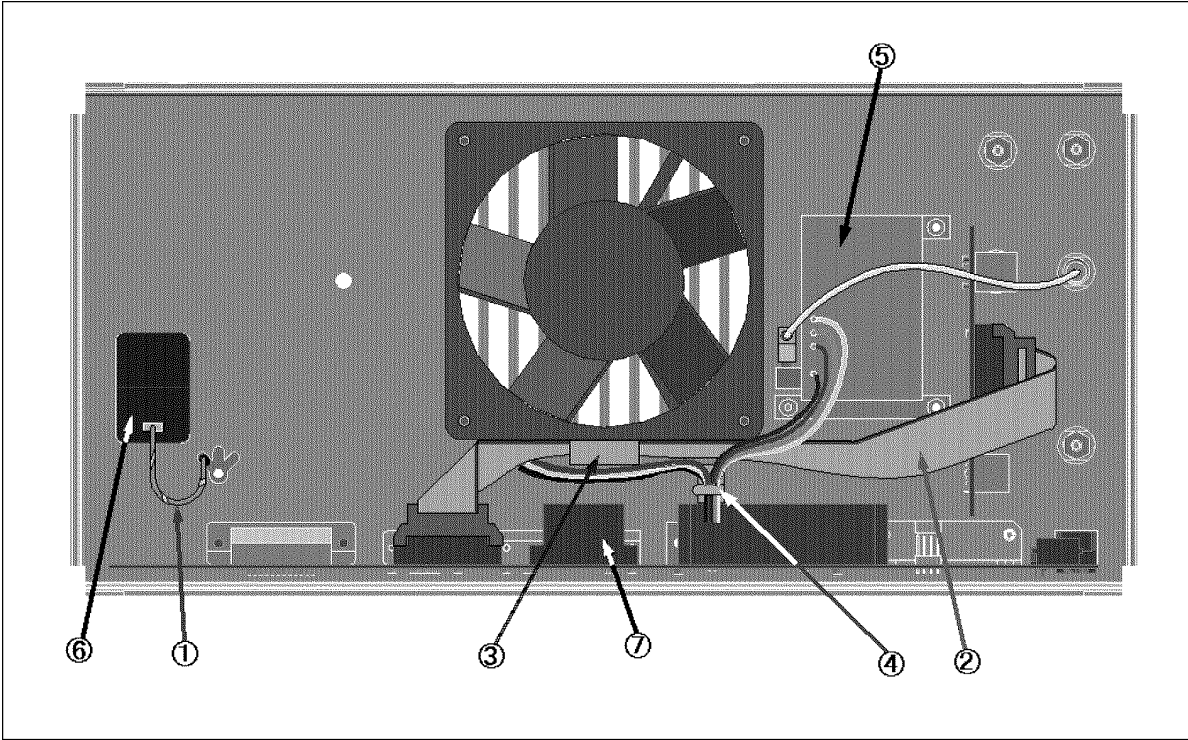


Table 9-20 Rear Assembly 3

Reference Designation	Agilent Part Number	Check Digit	Qty.	Description
1	1250-0252	6	1	BNC Connector
	2190-0102	8	1	Washer
	2950-0035	8	1	Nut
	See Table 9-2		1	RF Cable “G”
2	1250-0252	6	1	BNC Connector
	2190-0102	8	1	Washer
	2950-0035	8	1	Nut
	See Table 9-2		1	RF Cable “B”
3	1250-0252	6	1	BNC Connector (Opt 1D5)
	2190-0102	8	1	Washer (Opt 1D5)
	2950-0035	8	1	Nut (Opt 1D5)
	E4970-61627	9	1	Cable (Opt.1D5)
	6960-0041		1	Plug Hole (standard)
4	1250-0252	6	1	BNC Connector
	2190-0102	8	1	Washer
	2950-0035	8	1	Nut
	04396-61635	6	1	RF Cable “E”
5	5041-9188	6	1	Rear Foot
	0515-1232	5	1	Screw-Mach M3.5
6	04396-61001	0	1	Fan Assembly
	0515-1598	6	1	Screw
	2190-0586	2	1	Washer
	3050-0893	9	1	Washer
7	5080-3923	7	1	Name Plate
8	04294-00213	3	1	Panel Rear

Figure 9-22 Rear Assembly 4

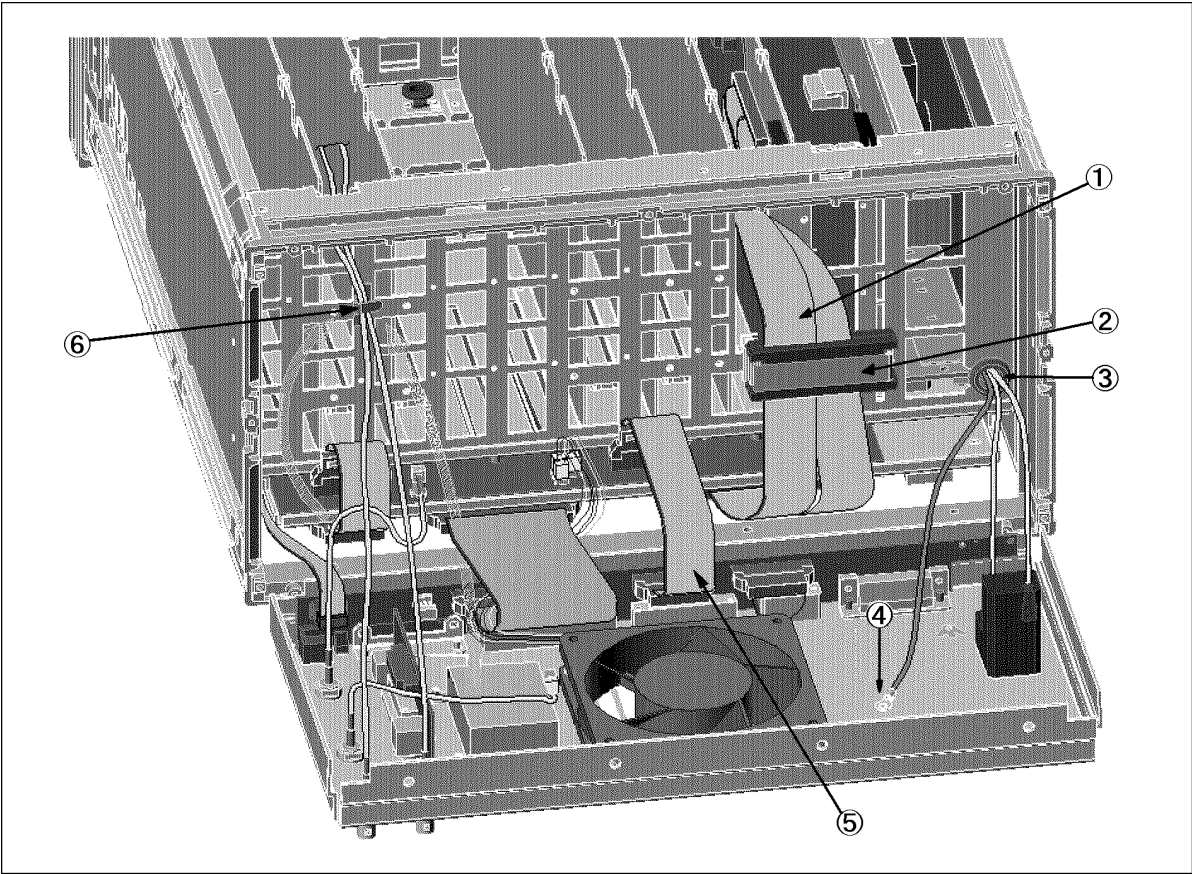


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Table 9-21 Rear Assembly 4

Reference Designation	Agilent Part Number	Check Digit	Qty.	Description
1	04268-61633	9	1	Wire Assembly
2	04396-61706	2	1	Cable
3	1400-0611	0	1	Cable Clamp
4	1400-1334	6	1	Cable Clamp
5	04395-61060	0	1	A60 Freq Ref (Opt 1D5 only)
	0515-1550	0	3	Screw M3-L 8 P-H (Opt 1D5 only)
	6960-0027	3	1	Plug Hole (Standard)
6	1252-6951	8	1	AC Inlet
	2110-0030	3	1	Fuse 5A 250V
	2110-1134	0	1	Fuse Drawer
7	04294-61653	5	1	Flat Cable

Figure 9-23 Rear Assembly 5

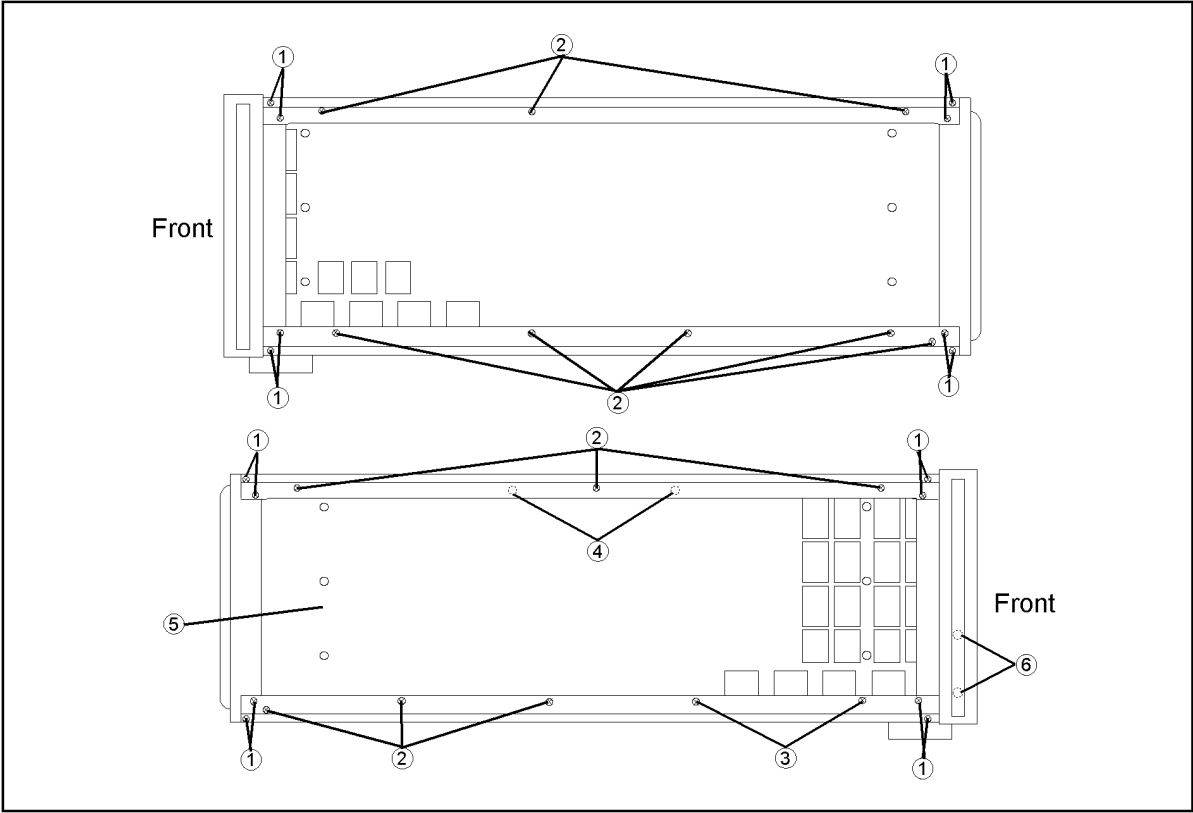


4294ase09022

Table 9-22 Rear Assembly 5

Reference Designation	Agilent Part Number	Check Digit	Qty.	Description
1	See Table 9-2		1	Flat Cable, A1 to A51
2	9170-1791	8	1	Magnetic Core
3	0400-0276	2	1	Grommet
4	0515-2079	0	1	Screw M4X8
5	04396-61663	0	1	Flat Cable
6	1400-1334	6	1	Cable Clamp

Figure 9-24 Side View

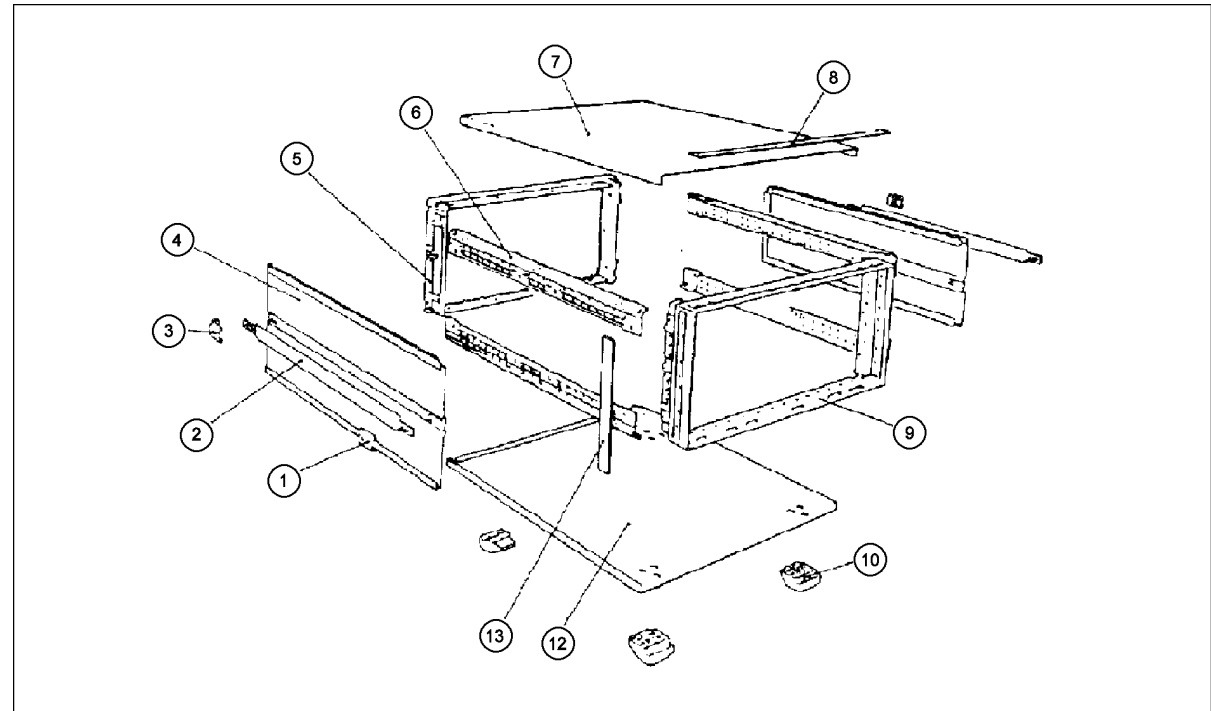


4294ase09023

Table 9-23 Side View

Reference Designation	Agilent Part Number	Check Digit	Qty.	Description
1	0515-1668	1	16	Screw Metric
2	0515-1719	3	14	Screw M4X10
3	0515-1718	2	2	Screw M4X12
4	0515-1011	8	2	Screw M4L6 (hidden)
5	04294-60011	5	1	Chassis
6	0515-0889	6	2	Screw M3.5

Figure 9-25 Chassis Assembly



4294ase09024

Table 9-24 Chassis Assembly

Reference Designation	Agilent Part Number	Check Digit	Qty.	Description
1	5041-9186	4	2	Cap-Front
	0515-1132	4	2	Screw-M5
2	5063-9210	1	2	Strap Handle
3	5041-9187	5	2	Cap-Rear
	0515-1132	4	2	Screw-M5
4	5002-3989	1	2	Side Cover
	08751-07001	5	2	Gasket
5	5021-5808	7	1	Rear Frame
6	5021-5837	2	4	Corner Strut
7	5002-1047	8	1	Top Cover
8	See Table 9-17		1	Top Trim
9	5022-1190	4	1	Front Frame
10	5041-9167	1	4	Foot
	1460-1345	5	2	Tilt Stand
12	5002-1088	7	1	Bottom Cover
13	See Table 9-17		2	Side Trim

Parts Replacement
Replaceable Part List

Table 9-25 Other Parts

Reference Designation	Agilent Part Number	Check Digit	Qty.	Description
1	04294-61001	7	1	100 Ω Resistor
2	1250-1859	1	1	BNC(m)-BNC(m) Adapter (Opt. 1D5)
3	1150-7970	1	1	Keyboard US English
4	See Figure 9-1		1	Power Cable
5	04294-900x0 ^{*1}	9	1	Operation Manual
6	04294-900x1 ^{*1}	0	1	Programming Manual
7	E2083-90005	0	1	HP I-BASIC Handbook
8	04294-18010	7	1	Sample Program Disk Set
9	04294-901x0 ^{*1}		1	Service Manual (Opt. 0BW)

*1. The number indicated by “x” in the part number of each manual, 0 for the first edition, is incremented by 1 each time a revision is made. The latest edition comes with the product.

Replacement Procedure

This Chapter describes how to replace the 4294A major assemblies. The cover and panel removal procedures that are required for some assembly replacements are described first. Then the replacement procedures for each major assembly are described.

Top Cover Removal

Tools Required

- Torx screwdriver, T15
- Pozidriv Screwdriver, pt size #2 (medium)

Procedure

1. Disconnect the power cable from the 4294A.
2. Remove the two rear feet behind the top cover.
3. Loosen the top cover rear screw.
4. Slide the top cover toward the rear and lift it off.

Bottom Cover Removal

Tools Required

- Torx screwdriver, T15
- Pozidriv Screwdriver, pt size #2 (medium)

Procedure

1. Disconnect the power cable from the 4294A.
2. Place the analyzer upside down.
3. Remove the two rear feet behind the bottom cover.
4. Loosen the bottom cover rear screw.
5. Slide the bottom cover toward the rear and lift it off.

Side Cover Removal

Tools Required

- Torx screwdriver, T15
- Pozidriv Screwdriver, pt size #2 (medium)

Procedure

1. Remove the top cover and the bottom cover as described in the “Top Cover Removal” and “Bottom Cover Removal” procedures.

Parts Replacement

Replacement Procedure

2. Remove the two screws at the side strap handle caps to remove the strap.
3. Slide off the side cover toward the rear.

Front Panel Removal

Tools Required

- Torx screwdriver, T15
- Pozidriv Screwdriver, pt size #2 (medium)
- Flat bladed screwdriver.

Procedure

1. Disconnect the power cable from the 4294A.
2. Place the 4294A upside down.
3. Remove four screws from the bottom of the front frame.
4. Turn the 4294A over into the correct position.
5. Peel off the side trim from the left side of the front frame.
6. Remove two screws from the left side of the front frame.
7. Remove the top trim strip from the front frame by prying the strip up with a flat screwdriver.
8. Remove five screws from the top of the front frame.
9. Remove the top cover as described in the “Top Cover Removal” procedure.
10. Remove the top shield.
11. Disconnect the cables connecting the front frame to the A51 board.
12. Gently pull the front panel knob to remove the front panel assembly from the front panel.

Rear Panel Removal

Tools Required

- Torx screwdriver, T15
- Pozidriv Screwdriver, pt size #1 (small), #2 (medium)

Procedure

1. Remove the top, bottom, and side covers as described in the “Top Cover Removal”, “Bottom Cover Removal” and “Side Cover Removal” procedures.
2. Place the 4294A upside down.
3. Remove four screws from the bottom of the rear frame.
4. Turn over the 4294A into the correct position.
5. Remove the four screws fixing the rear panel.

6. Gradually pull the rear panel assembly out from the rear frame.

A1 CPU Board Replacement

Tools Required

- Torx screwdriver, T15
- Pozidriv Screwdriver, pt size #1 (small), #2 (medium)
- IC Extractor

Procedure

1. Remove the bottom cover as described in the “Bottom Cover Removal” procedure.
2. Disconnect all cables and wires from A1 CPU Board.
3. Remove the EEPROM from A1 (see Figure 9-8).
4. Mount the EEPROM on the replacement A1.

A2/A8/A50/A51 Replacement

Tools Required

- Torx screwdriver, T15
- Pozidriv Screwdriver, pt size #1 (small), #2 (medium)

Procedure

1. Remove the top covers as described in the “Top Cover Removal” procedure.
2. Remove the top shield.
3. Disconnect all cables from the A2/A8/A50/A51 board.
4. Lift the extractors at the top of the A2/A8/A50/A51 board, and lift out the board out.

A3 Hp Amplifier Replacement

Tools Required

- Torx screwdriver, T15
- Pozidriv Screwdriver, pt size #1 (small), #2 (medium)

Procedure

1. Remove the top cover as described in the “Top Cover Removal” procedure.
2. Remove the top shield.
3. Disconnect cables “K” and “L” from the A2 board.
4. Disconnect all cables from the A3 Hp Amplifier.
5. Lift the extractors at the top of the A3 Hp Amplifier, and lift the A3.

Parts Replacement

Replacement Procedure

6. Disconnect the cable “C” from the A3 Hp Amplifier, and connect it to the replacement A3.

A4 Lc Amplifier Replacement

Tools Required

- Torx screwdriver, T15
- Pozidriv Screwdriver, pt size #1 (small), #2 (medium)

Procedure

1. Remove the top cover as described in the “Top Cover Removal” procedure.
2. Remove the top shield.
3. Disconnect the cables “K” and “L” from the A2 board.
4. Disconnect the cable “D” from the A3 board.
5. Disconnect all cables from the A4 Lc Amplifier.
6. Lift the extractors at the top of the A4 Lc Amplifier, and lift the A4 board out.

A5 IV Convertor & Lp Amplifier Replacement

Tools Required

- Torx screwdriver, T15
- Pozidriv Screwdriver, pt size #1 (small), #2 (medium)

Procedure

1. Remove the top cover as described in the “Top Cover Removal” procedure.
2. Remove the top shield.
3. Disconnect the cables “K” and “L” from the A2 board.
4. Disconnect the cable “D” from the A3 board.
5. Disconnect the cable “F” from the A4 board.
6. Disconnect all cables from the A5 board.
7. Lift the extractors at the top of the A5 board, and lift the A5 board out.

A6 Vector Generator Replacement

Tools Required

- Torx screwdriver, T15
- Pozidriv Screwdriver, pt size #1 (small), #2 (medium)

Procedure

1. Remove the top cover as described in the “Top Cover Removal” procedure.

2. Remove the top shield.
3. Disconnect the cables “K” and “L” from the A7 board.
4. Disconnect the cable “D” from the A3 board.
5. Disconnect all cables from the A6 board.
6. Lift the extractors at the top of the A6 board, and lift the A6 board out.

A7 Synthesizer Replacement

Tools Required

- Torx screwdriver, T15
- Pozidriv Screwdriver, pt size #1 (small), #2 (medium)

Procedure

1. Remove the top cover as described in the “Top Cover Removal” procedure.
2. Remove the top shield.
3. Disconnect the cable “D” from the A8 board.
4. Disconnect all cables from the A7 Synthesizer.
5. Lift the extractors at the top of the A7 board, and lift the A7 board out.

A9 Floating Power Supply Replacement

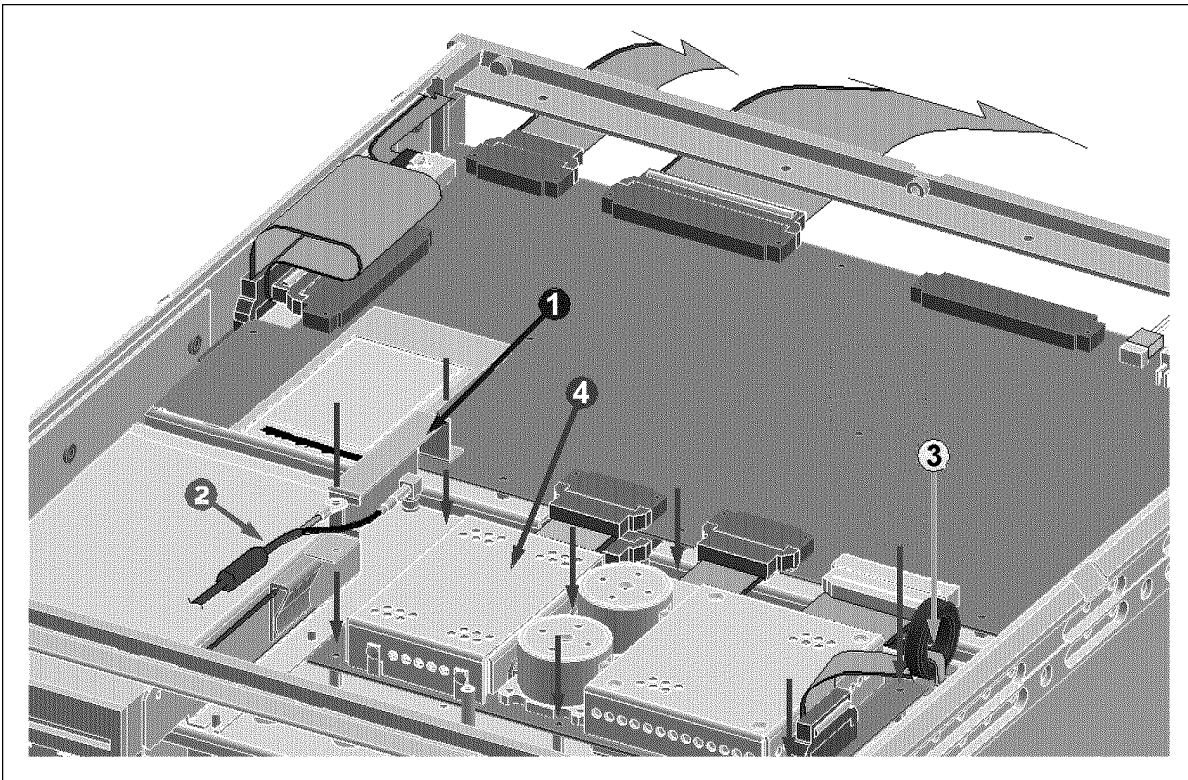
Tools Required

- Torx screwdriver, T15
- Pozidriv Screwdriver, pt size #1 (small), #2 (medium)

Procedure

1. Remove the bottom cover as described in the “Bottom Cover Removal” procedure.
2. Remove the shield (item “” in Figure 9-26).

Figure 9-26 **A9 Floating Power Supply**



4294ase09025

3. Disconnect the cables (item 1 and 2) from the A9 board.
4. Remove five screws fixing the A9 board.
5. Lift the A9 board (item 1).

A53 FDD Removal

Tools Required

- Torx screwdriver, T15
- Pozidriv Screwdriver, pt size #1 (small), #2 (medium)

Procedure

1. Remove the bottom cover as described in the “Bottom Cover Removal” procedure.
2. Remove the shield case from the chassis.
3. Remove the FDD from the shield case.
4. Disconnect all cables from FDD.

A52 LCD Removal

Tools Required

- Torx screwdriver, T15
- Pozidriv Screwdriver, pt size #1 (small), #2 (medium)

Procedure

1. Remove the front panel as described in the “Front Panel Removal” procedure.
2. Remove the LCD’s cover.
3. Pull the flat cable out from the magnetic core stuck on the cover.
4. Remove the LCD Assembly from the cover.
5. Remove the shield from the cover.
6. Disconnect the cable from the inverter.

A40 Preregulator Replacement

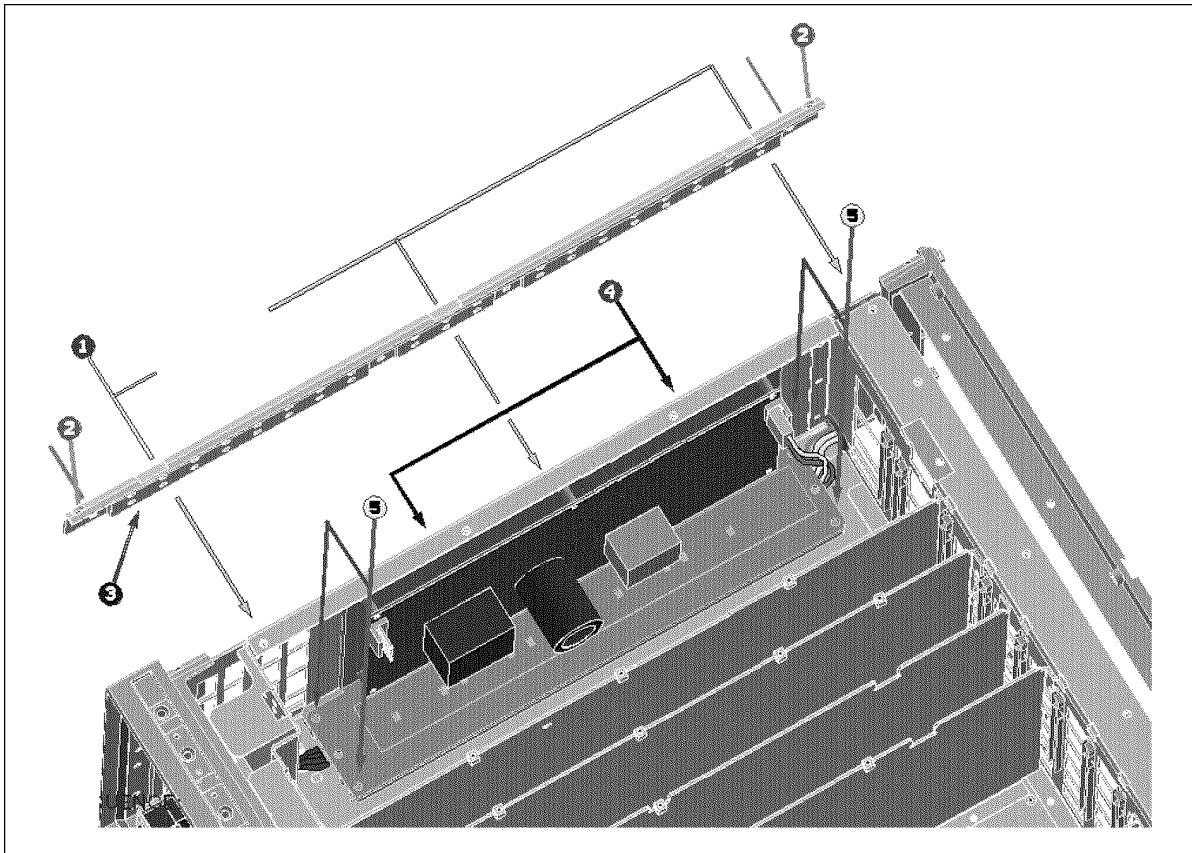
Tools Required

- Torx screwdriver, T15
- Pozidriv Screwdriver, pt size #1 (small), #2 (medium)

Procedure

1. Remove the top, bottom and left side covers as described in the “Top Cover Removal”, “Bottom Cover Removal” and “Side Cover Removal” procedures.
2. Remove the top shield.
3. Remove the A50 board as described in “A2/A8/A50/A51 Replacement”.
4. Remove the shield between the A50 board and the Preregulator.
5. Remove all cables connected to the preregulator.
6. Remove the seven screws (item ~ and !) to remove the side strut (item Æ).
7. Remove the two screws at the side of the chassis. (item Ø)
8. Remove the four screws (item ×) from the preregulator.
9. Gradually lift the preregulator.

Figure 9-27 **Preregulator Replacement**



4294ase09026

Power Switch Replacement

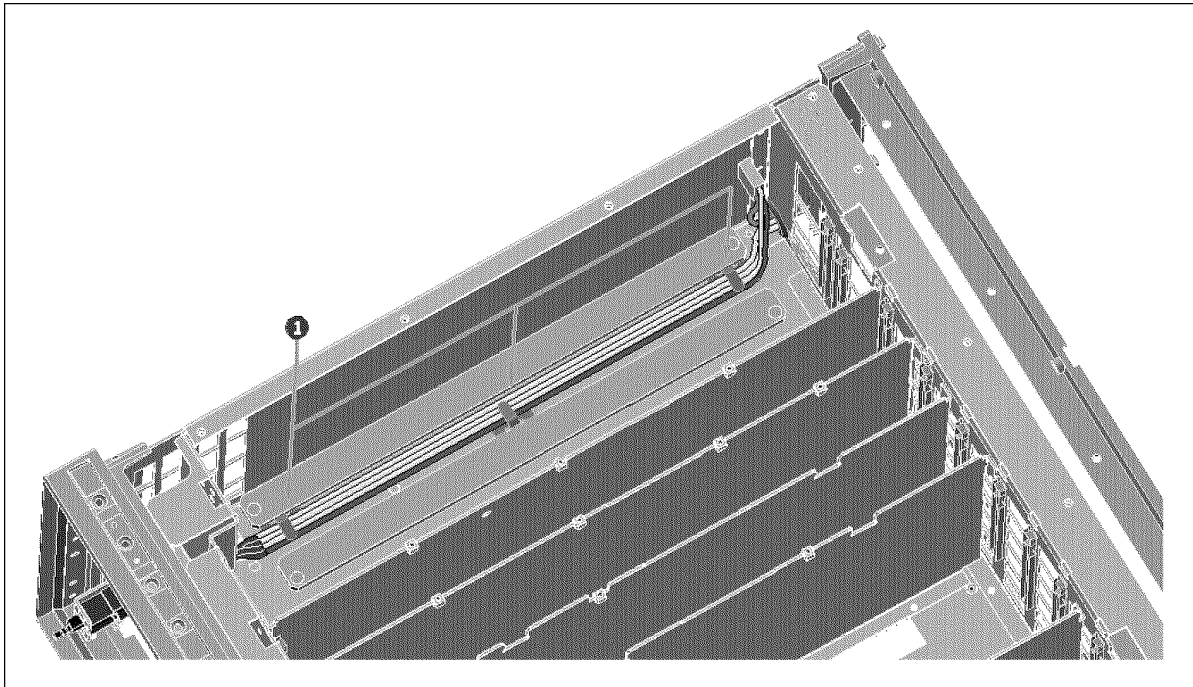
Tools Required

- Torx screwdriver, T15
- Pozidriv Screwdriver, pt size #1 (small), #2 (medium)

Procedure

1. Remove the rear panel and the Preregulator as described in the “Rear Panel Removal” and “A40 Preregulator Replacement” procedures.
2. Release the power switch cable from the cable clamp. (item “ in Figure 9-28)

Figure 9-28 **Cable Clamp**



4294ase09027

3. Remove the angel from the chassis.
4. Disconnect the power switch cable from the rear panel.

10

Post Repair Procedures

This chapter lists the procedures required to verify the 4294A operation after an assembly is replaced with a new one.

POST REPAIR PROCEDURES

Table 10-1 *Post Repair Procedures* lists the required procedures that must be performed after the replacement of an assembly or the EEPROM. These are the recommended minimum procedures to ensure that the replacement is successfully completed.

When you replace an assembly or the EEPROM on the A1 CPU, perform the adjustments and updating correction constants (CC) in Table 10-1. Then perform the operational verifications and performance verifications listed in Table 10-1.

For the detailed procedure of the adjustments and updating correction constants, see *Adjustments* Chapter. For the detailed operational verification procedures, see this manual's chapter specified in Table 10-1. For detailed performance verification procedures, see *Performance Test* Chapter in this manual.

Table 10-1 Post Repair Procedures

Replaced Assembly or Part	Adjustments Correction Constants (CC)	Verification
A1 CPU	Firmware Installation ^{*1}	<i>Inspect the Power On Sequence</i> ^{*2} Internal Test 1: A1 CPU ^{*1} Internal Test 2: A1 VOLATILE MEMORY ^{*1}
A1 EEPROM	Write ID All CC Items	<i>Inspect the Power On Sequence</i> ^{*2} All Performance Test Items
A2 High Current	DC Bias Monitor CC DC Bias Level CC OSC Level Monitor CC OSC Level CC	<i>Inspect the Power On Sequence</i> ^{*2} External Test 20: ALL ANALOG ^{*2} OSC Level Accuracy Test DC Bias Monitor Accuracy Test DC Bias Level Accuracy Test
A3 Hp Amp.	Hpot-Amplifier Offset CC Relative Impedance CC OSC Level Monitor CC OSC Level CC Impedance Measurement CC	<i>Inspect the Power On Sequence</i> ^{*2} External Test 20: ALL ANALOG ^{*2} OSC Level Accuracy Test Measurement Accuracy Test
A4 Lc Amp.	Null Loop Phase CC Relative Impedance CC OSC Level Monitor CC Impedance Measurement CC	<i>Inspect the Power On Sequence</i> ^{*2} External Test 20: ALL ANALOG ^{*2} Measurement Accuracy Test
A5 IV Converter & Lp Amp.	Lpot-Mixer Offset CC Null Loop Phase CC DC Bias Monitor CC DC Bias Level CC	<i>Inspect the Power On Sequence</i> ^{*2} External Test 20: ALL ANALOG ^{*2} DC Bias Monitor Accuracy Test DC Bias Level Accuracy Test Measurement Accuracy Test
A6 Vec Gene	Null Detector Offset CC Null Loop Phase CC	<i>Inspect the Power On Sequence</i> ^{*2} External Test 20: ALL ANALOG ^{*2} Measurement Accuracy Test

Table 10-1 Post Repair Procedures

Replaced Assembly or Part	Adjustments Correction Constants (CC)	Verification
A7 Synthesizer	Frequency Accuracy CC Image Rejection CC Null Detector Offset CC Null Loop Phase CC Relative Impedance CC OSC Level Monitor CC OSC Level CC Impedance Measurement CC	<i>Inspect the Power On Sequence</i> *2 Frequency Accuracy Test OSC Level Accuracy Test Measurement Accuracy Test
A8 Vector Ratio Detector	Image Rejection CC Relative Impedance CC OSC Level Monitor CC	<i>Inspect the Power On Sequence</i> *2 External Test 20: ALL ANALOG *2 Measurement Accuracy Test
A9 Floating Power Supply	None	<i>Inspect the Power On Sequence</i> *2
A20 Motherboard	None	<i>Inspect the Power On Sequence</i> *2
A30 Keyboard	None	<i>Inspect the Power On Sequence</i> *2 External Test 17: FRONT PANEL *1
A32 I-BASIC Interface	None	<i>Inspect the Power On Sequence</i> *2 Check the A32 I-BASIC Interface and the mini DIN Keyboard *1
A34 EXT I/O	None	<i>Inspect the Power On Sequence</i> *2
A40 Pre-Regulator	None	<i>Inspect the Power On Sequence</i> *2
A50 DC-DC Converter	None	<i>Inspect the Power On Sequence</i> *2
A51 GSP	None	<i>Inspect the Power On Sequence</i> *2 Internal Test 4: A51 GSP *1
A52 LCD	None	<i>Inspect the Power On Sequence</i> *2
A53 FDD	None	<i>Inspect the Power On Sequence</i> *2 External Test 18: FLOPPY DISK DRIVE *1
A60 High Stability Frequency Reference	Frequency Reference Adjustment	<i>Inspect the Power On Sequence</i> *2 Frequency Accuracy Test (Opt.1D5)

*1. See the Digital Control Troubleshooting chapter.

*2. See the Troubleshooting chapter.

Post Repair Procedures
POST REPAIR PROCEDURES

A Manual Changes

This appendix contains the information required to adapt this manual to earlier versions or configurations of the 4294A than the current printing date of this manual. The information in this manual applies directly to an 4294A whose serial number prefix is listed on the title page of this manual.

Manual Changes

To adapt this manual to your 4294A, refer to Table A-1 and Table A-2.

Table A-1 **Manual Changes by Serial Number**

Serial Prefix or Number	Make Manual Changes

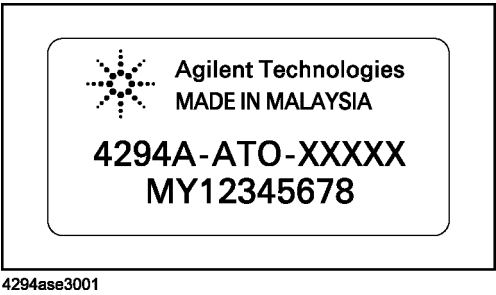
Table A-2 **Manual Changes by Firmware Version**

Version	Make Manual Changes

Agilent Technologies uses a two-part, ten-character serial number that is stamped on the serial number plate (see Figure A-1). The first five characters are the serial prefix and the last five digits are the suffix.

Press **[System] - DIAGNOSTIC TEST - FIRMWARE REVISION** keys to display the firmware version of the 4294A.

Figure A-1 **Serial Number Plate**



B Power Requirement

Replacing Fuse

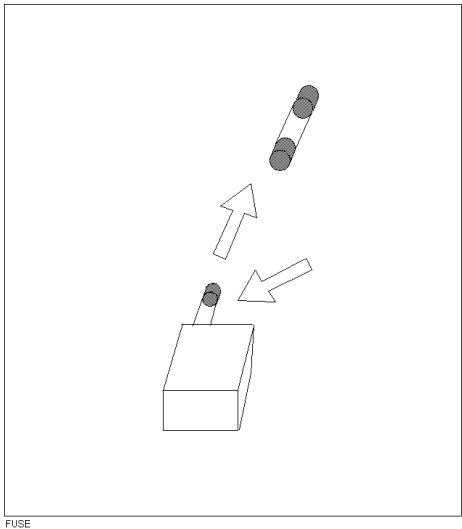
Fuse Selection

Select proper fuse according to the Table B-1.

Table B-1 Fuse Selection

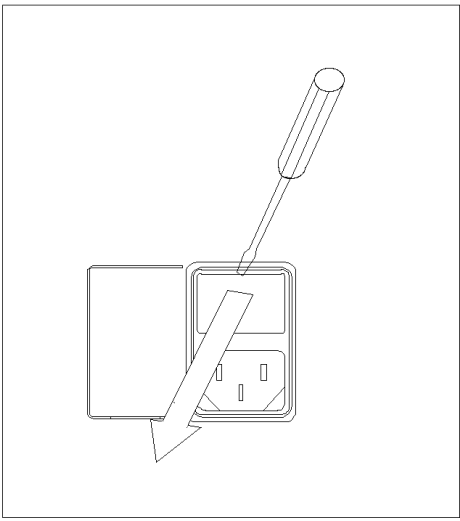
Fuse Rating/Type	Fuse Part Number
5A 250Vac UL/CSA type Time Delay	2110-0030

For ordering the fuse, contact your nearest Agilent Technologies Sales and Service Office.



FUSE

Open the cover of AC line receptacle on the rear panel using a small minus screwdriver.



To check or replace the fuse, pull the fuse holder and remove the fuse. To reinstall the fuse, insert a fuse with the proper rating into the fuse holder.

Power Requirements

The 4294A requires the following power source:

Voltage : 90 to 132 Vac, 198 to 264 Vac
Frequency : 47 to 63 Hz
Power : 300 VA maximum

Power Cable

In accordance with international safety standards, this instrument is equipped with a three-wire power cable. When connected to an appropriate ac power outlet, this cable grounds the instrument frame.

The type of power cable shipped with each instrument depends on the country of destination. Refer to Figure B-1 for the part numbers of the power cables available.

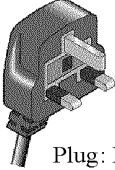
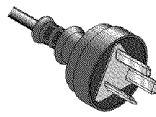
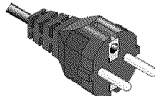
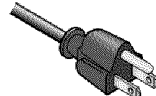

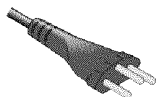
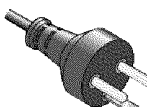

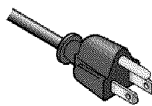
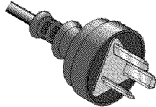
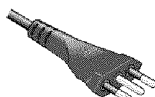

WARNING

For protection from electrical shock, the power cable ground must not be defeated.

The power plug must be plugged into an outlet that provides a protective earth ground connection.

Power Requirement
Power Requirements

Figure B-1 Power Cable Supplied

<p>OPTION 900</p>  <p>United Kingdom</p> <p>Plug: BS 1363/A, 250V, 10A Cable: 8120-1351, 8120-8705</p>	<p>OPTION 901</p>  <p>Australia/New Zealand</p> <p>Plug: AS 3112, 250V, 10A Cable: 8120-1369</p>
<p>OPTION 902</p>  <p>Continental Europe</p> <p>Plug: CEE 7 Standard Sheet VII, 250V, 10A Cable: 8120-1689</p>	<p>OPTION 903</p>  <p>U.S./Canada</p> <p>Plug: NEMA 5-15P, 125V, 10A Cable: 8120-1378</p>
<p>OPTION 904</p>  <p>U.S./Canada</p> <p>Plug: NEMA 6-15P, 250V, 6A Cable: 8120-0698</p>	<p>OPTION 906</p>  <p>Switzerland</p> <p>Plug: SEV Type 12, 250V, 10A Cable: 8120-2104</p>
<p>OPTION 912</p>  <p>Denmark</p> <p>Plug: SR 107-2-D, 250V, 10A Cable: 8120-2956</p>	<p>OPTION 917</p>  <p>India/Republic of S. Africa</p> <p>Plug: IEC 83-B1, 250V, 10A Cable: 8120-4211</p>
<p>OPTION 918</p>  <p>Japan</p> <p>Plug: JIS C 8303, 125V, 12A Cable: 8120-4753</p>	<p>OPTION 920</p>  <p>Argentina</p> <p>Plug: Argentine Resolution 63, Annex IV, 250V, 10A Cable: 8120-6870</p>
<p>OPTION 921</p>  <p>Chile</p> <p>Plug: CEI 23-16, 250V, 10A Cable: 8120-6978</p>	<p>OPTION 922</p>  <p>China</p> <p>Plug: GB 1002, 250V, 10A Cable: 8120-8376</p>
<p>NOTE: Each option number includes a 'family' of cords and connectors of various materials and plug body configurations (straight, 90° etc.).</p>	

power_e

C Error messages

The 4294A provides error messages to indicate its operating status. This appendix describes the error messages of the 4294A.

Error messages are outputted on the 4294A's LCD or through GPIB. This section gives you the description of each error message and its remedy.

NOTE

If an error with a positive error number occurs, only its error message is displayed on the LCD following the string of “CAUTION:” (in this case, its error number is not displayed). On the other hand, if an error with a negative error number occurs, “CAUTION: GPIB error occurred” is always displayed on the LCD. When error messages are outputted through GPIB, their error number and error message are outputted for all errors (“CAUTION:” is not added). Some messages displayed on the LCD do not have “CAUTION:”; these are not error messages. Messages without “CAUTION:” are not described here.

Errors with a negative error number are basically general errors for GPIB instruments defined by IEEE488.2. On the other hand, errors with a positive error number are ones defined specifically for the 4294A.

Order of Alphabet

A

135

ADC OVERLOAD

Due to, for example, a sudden change of the connection of a DUT, the internal circuit (ADC) was temporarily overloaded. Measurement data at the occurrence of this error is invalid. If this error often occurs in usual measurements, the instrument may fail. In this case, Contact your local Agilent Technologies sales office or the company you purchased this instrument from.

10

ADDITIONAL STANDARDS NEEDED

Before the measurement of all the calibration standards (OPEN, SHORT, LOAD) required to complete user calibration or four-terminal pair extension setting were completed, an GPIB command (CALDON or ECALDON) to calculate error coefficients was sent. The command was invalid. Measure all the required calibration standards.

B

17

BACKUP DATA LOST

The contents of the battery-backed memory (SRAM), storing user calibration data, fixture compensation data, GPIB address, IP address, and so on, were lost, causing an error (check sum error). Its cause is running out of the battery for backup. To enable the battery backup for the memory again, turn on the power and keep it approximately 10 minutes to charge the battery completely.

-160

Block data error

An error not included in error numbers between -161 and -169 occurred during the syntax analysis of block data.

-168

Block data not allowed

A block data element was received at where the 4294A did not accept any block data elements.

136

BRIDGE UNBALANCED

Because the connection of a DUT or the setting for it was incorrect, the internal circuit (BRIDGE) temporarily could not perform measurements (UNBALANCED).

- The setting of the four-terminal pair extension (NONE, 4TP 1M, 4TP 2M, 7mm 42942A, PROBE 42941A) may not match with the fixture, cable, adapter, or probe actually connected. Check and correct the setting.
- The setup (acquisition of calibration data) for the setting of the four-terminal pair extension may have failed. If necessary, perform the setup again.
- Some measured DUTs may cause this error due to their characteristics. In this case, the error may be avoided by changing the measurement condition (for example, lowering the measurement signal level).

If this error often occurs in usual measurements, the instrument may fail. In this case, Contact your local Agilent Technologies sales office or the company you purchased this instrument from.

C

13

CALIBRATION ABORTED

One of the following occurred.

- In the middle of or after the completion of the setup for user calibration or fixture compensation (measurement of required calibration data and calculation and storage of error coefficients), the setting of calibration points (FIXED or USER) was changed. The current setup and error coefficients previously stored are now invalid.
- When the setting of calibration points was USER, in the middle of or after the completion of the setup for user calibration or fixture compensation (measurement of required calibration data and calculation and storage of error coefficients), the sweep condition (sweep range, sweep parameter, number of sweep points, sweep type) was changed. The current setup and error coefficients previously stored are now invalid.
- In the middle of the setup for user calibration or four-terminal pair extension (measurement of required calibration data and calculation and storage of error coefficients), the setup was canceled (the cancel key, CALQUI command, or ECALQUI command was executed). The setup is invalid. However, error coefficients previously stored are available.

If necessary, perform the setup for user calibration, fixture compensation, or four-terminal pair extension.

11

CALIBRATION REQUIRED

In user calibration or fixture compensation, though error coefficients based on the measurement of the required calibration standards (OPEN, SHORT, or LOAD) had not been acquired, an GPIB command (CALST ON, COMCA ON, COMCB ON, or COMCC ON) that turned on the user calibration function or fixture compensation function was sent. Valid error coefficients were not detected. The command was invalid. For user calibration, it is required to measure all the calibration standards (OPEN, SHORT, LOAD) and acquire error coefficients based on the measurement. On the other hand, for fixture compensation, it is required to measure a calibration standard (OPEN, SHORT, or LOAD) corresponding to the fixture compensation function (OPEN compensation function, SHORT compensation function, or LOAD compensation function) you want to turn on and obtain

error coefficients based on the measurement.

-281

Cannot create program

Programs cannot be created. Insufficient memory is suspected.

35

CAN'T CALCULATE EQUIVALENT PARAMETERS

Because measurement data does not match with the selected equivalent circuit, equivalent circuit parameters cannot be calculated. Acquire data again or select another equivalent circuit.

82

CAN'T CHANGE -ANOTHER CONTROLLER ON BUS

When an active controller was on the same GPIB bus, you attempted to set the 4294A as a system controller. Unless another active controller is removed from the same GPIB bus, you cannot set the 4294A as a system controller.

133

CAN'T CHANGE ON LIST SWEEP

When the sweep type was set to the list sweep, you attempted to execute a command to specify the lower limit of a partial search range (SEARMIN) or a command to specify the upper limit of a partial search range (SEARMAX) and, as a result, the command was ignored. When the sweep type is the list sweep, you cannot specify a partial search range using the lower limit and the upper limit. Before specifying a partial search range using the lower limit and the upper limit, specify a sweep type other than the list sweep (command: SWPT LIN or SWPT LOG).

130

CAN'T CHANGE ON ZERO SPAN

During the execution of the list sweep when the sweep span of each segment was zero, you attempted to change the list sweep span (integrated total span of individual segments specified as the horizontal axis of the graph for the list sweep) to the single span (the way to specify a linear frequency axis for the horizontal axis of the graph whose left edge and right edge are the minimum frequency and the maximum frequency within all segments) using the LIST SPAN [] key or the LISAN SINGLE command and, as a result, the command was ignored. When executing the list sweep while the sweep span of each segment being zero, the list sweep span is automatically set to the segment span and cannot be changed.

114

CAN'T SAVE GRAPHICS WHEN COPY IN PROGRESS

You commanded to save the graphics screen during the execution of copying (outputting to a printer), but the graphics screen cannot be saved during output to a printer.

-140

Character data error

An error not included in error numbers between -141 and -149 occurred during the syntax analysis of a character data element.

-148

Character data not allowed

A character data element (that did not violate the standard) was received at where the 4294A did not accept any character data elements. For example, a parameter must be enclosed with double quotation marks (") but they are missing.

-144

Character data too long

The length of the character data element exceeds 12 characters. (Refer to IEEE488.2,7.7.1.4.)

-100

Command error

A comprehensive syntax error occurred for which the 4294A could not detect further details of the error. This error code simply indicates the occurrence of a command error that is defined in IEEE488.2,11.5.1.1.4.

75 **COMMAND IGNORED -SEGMENT NOT DONE YET**

During the edit of a segment in the list sweep table or limit line table, an inappropriate edit command (EDIT LIML, EDITLIST, LIMCLEL, LIMSEDI, LIMSADD, LIMSDEL, SLEL, SEDI, SADD, SEGM) was sent and, as a result, the command was ignored. If necessary, execute SDON (command to finish the edit of a list sweep segment), or LIMSDON (command to finish the edit of a limit segment) to finish the edit of the segment, and then perform the setting.

74 **CURRENT EDITING SEGMENT SCRATCHED**

During the edit of a segment in the list sweep table or limit line table, a key or command not related to edit of the table was executed, and the segment that was being edited became invalid. To avoid this, press “done key” in the segments menu, SDON (command to finish the edit of a list sweep segment), or LIMSDON (command to finish the edit of a limit segment), and then perform other settings.

D

91 **DATA AND MEMORY TRACE NOT DISPLAYED**

When both of the data trace and the memory trace were not displayed, you attempted to change the setting of the data & memory couple (command: SCAC ON or SCAC OFF). To change the setting of the data & memory couple, first, display both of the data trace and the memory trace (command: DISP DATM).

-230 **Data corrupt or stale**

The data may be invalid. Or, a newly initiated read operation has not been completed since the latest access.

-225 **Data out of memory**

To perform the requested operation, the 4294A does not have enough memory.

-222 **Data out of range**

A data element (that did not violate the standard) out of the range the 4294A defined was received.

231 **Data questionable**

Data may be questionable. The accuracy of measurement data may be deteriorated.

93 **DATA TRACE NOT DISPLAYED**

When the data trace was not displayed, you attempted to set the function that needed the display of the data trace and, as a result, the command was ignored. For example, a command (MKRO DATA or SCAF DATA) corresponding to the MARKER ON [DATA] key or the SCALE FOR [DATA] key was sent. Before setting the function that needs the display of the data trace, display the data trace (command: DISP DATA or DISP DATM).

-104 **Data type error**

The parser recognized impossible data elements. For example, numeric value or string data was expected, but block data was sent.

- 138 **DCBIAS CONSTANT OPERATION FAILED**
- When the DC bias mode was constant voltage (VOLT CONSTANT) or constant current (CURRENT CONSTANT), the actual DC bias output did not converge to the set DC voltage value or DC current value, or it exceeded the set voltage limit or current limit. If a DUT needs time to be stabilized after DC bias is applied, specify the point delay. If necessary, change the voltage limit value or the current limit value.
- 139 **DCBIAS LEVEL MONITOR NOT VALID**
- When the DC bias level monitor was not on, you attempted to execute the command to turn on the marker DC voltage level monitor or the marker DC current level monitor (MKRMON DCV or MKRMON DCI) and, as a result, the command was ignored. Before turning on the marker DC voltage level monitor or the marker DC current level monitor, turn on the corresponding DC bias level monitor (command: BMON VOLT or BMON CURR).
- 137 **DCBIAS OVERLOAD**
- When the DC bias was applied, DC current that exceeded the setting of the DC bias range (<1mA, <10mA, or <100mA) was supplied from the bias source, or the overcurrent limit circuit of the DC bias source operated. Increase the setting of the DC bias range, or decrease the level of the applied DC bias.
- 99 **DELTA MARKER OFF**
- When the delta marker was not displayed, you attempted to execute a function that needed the display of the delta marker and, as a result, the command was ignored. For example, when the delta marker was not displayed, a command corresponding to the MKRD?SPAN key (MKRDSPAN) was sent. Before executing a function using the delta marker, first display the delta marker (command: DMKR ON).
- 118 **DEVICE TYPE IS NOT DOS**
- The execution of write access to the mass storage could not be executed because the format type of the mass storage was not DOS.
- 37 **DISPLAY BUFFER IS FULL**
- The use of the DRAW or MOVE command of HP Instrument BASIC made 4294A's display buffer full. Further write to the display buffer is impossible.

E

- 194 **EEPROM WRITE FAIL**
- A write error was detected in the memory (EEPROM) to store the OPEN, SHORT, and LOAD data for the four-terminal pair extension setting. Contact your local Agilent Technologies sales office or the company you purchased this instrument from.
- 200 **Execution error**
- A comprehensive execution error occurred for which the 4294A could not detect further details of the error. This error code simply indicates the occurrence of an execution error that is defined in IEEE488.2,11.5.1.1.5.
- 123 **Exponent too large**
- The absolute value of the exponent exceeds 32,000. (Refer to IEEE488.2,7.7.2.4.1.)
- 178 **Expression data not allowed**

An equation data element was received at where the 4294A did not accept any equation data elements.

-170

Expression error

An error not included in error numbers between -171 and -179 occurred during the syntax analysis of equation data.

F

-257

FILE NAME ERROR

There was an error in the filename and, as a result, the command was not executed correctly.

This message is displayed, for example, when you attempt to copy a file using the same filename.

-256

File name not found

The specified filename was not found and, as a result, the command was not executed correctly. This message is displayed, for example, when you attempt to read/write a file that does not exist on the disk.

143

FLOATING POINT ERROR OCCURED

Due to the execution of an application inside the instrument for inappropriate data sent from outside the instrument, an error for floating point operations occurred inside the instrument. The result of the operation may be incorrect. Contact your local Agilent Technologies sales office or the company you purchased this instrument from.

85

FORMAT NOT VALID FOR COMPLEX MEASUREMENT

When COMPLEX Z-Y (i.e., complex parameter measurement) was selected as a measurement parameter, you attempted to select a display format not available for the measurement parameter, for example, the linear scale format (FMT LINY command) and, as a result, the command was ignored. When COMPLEX Z-Y is selected as a measurement parameter, set the display format to the complex plane display format (command: FMT COMP) or the polar coordinates display format (command: FMT POLA).

86

FORMAT NOT VALID FOR SCALOR MEASUREMENT

When a measurement parameter other than COMPLEX Z-Y (i.e., scalar parameter measurement) was selected, you attempted to select a display format not available for the measurement parameter, for example, the complex plane display format (command: FMT COMP) and, as a result, the command was ignored. When a measurement parameter other than COMPLEX Z-Y is selected, select a display format from the linear scale format (command: FMT LINY), the log scale format (command: FMT LOGY), or the percent format (command: FMT PERC).

131

FREQUENCY SWEEP ONLY

When a sweep parameter other than the frequency was specified, you attempted to execute an equivalent circuit analysis command (CALECPARA and so on). You can execute the equivalent circuit analysis only when the sweep parameter is the frequency.

G

-105

GET not allowed

A group execution trigger (GET) was received in a program message. (Refer to IEEE488.2,7.7.)

H

-240

Hardware error

A hardware error.

The program command could not be executed due to an hardware-related error. An error other than -241 to -249 occurred.

-241

Hardware missing

The received command or Query complied with the standard but could not be executed due to hardware-related reasons (for example, the option was not installed).

-111

Header separator error

The header separator is wrong.

This error is displayed when a character other than a defined header follows the header. For example, when, though “*SRE 4” is correct, a character follows the header without a space like “*SRE4”, this error is displayed.

-114

Headers Suffix out of range

The suffix of the header is out of range. The suffix of a numeral parameter that follows the SCPI command makes the header invalid.

I

-224

Illegal parameter value

The value of the parameter is illegal.

-282

Illegal program name

The program name is illegal. This message is displayed, for example, when you attempt to delete a program name that does not exist, define an existing program name again, or refer to a program that does not exist.

-283

Illegal variable name

The variable name is illegal. This message is displayed when you attempt to refer to a variable that does not exist.

-213

Init ignored

Another measurement was being executed and the measurement start request was ignored.

141

INSUFFICIENT MEMORY

Multiple processes were executed at the same time and the memory was exhausted, which caused the last process to be aborted. For example, if the execution of an HP Instrument BASIC program, the printout of the screen, and the transfer of the data array are executed at the same time, the memory of the system is exhausted, and this message may be displayed. In this case, terminate some of the processes and then perform the next operation.

-161	<p>Invalid block data</p> <p>Block data was expected but given block data was invalid for some reasons. (Refer to IEEE488.2,7.7.6.2.) For example, the END message was received before the length of the block data was reached.</p>
-101	<p>Invalid character</p> <p>Invalid characters exist in the program message string. For example, for a correct program message, "MEAS IRIM," an ampersand (&) is inserted by mistake, like "MEAS&IRIM."</p>
-141	<p>Invalid character data</p> <p>There are invalid characters in a character data element or the received parameter is not valid. For example, though a correct program message was "MEAS LSR," a wrong program message, "MEAS LSD," was received.</p>
-121	<p>Invalid character in number</p> <p>An invalid character for the data type of the syntax analysis target was received. For example, alphabetical characters exist in a decimal value, or "9" exists in octal data.</p>
154	<p>INVALID DATE</p> <p>You attempted to specify the date of the built-in clock using the DATE key or the SETCDATE command, but the date was out of range and, as a result, the setting you attempted to execute became invalid. The settable range is: 1900 to 2099 for year, 1 to 12 for month, and 1 to 31 for day. Also, you cannot specify a date that does not exist actually. Specify correct date data.</p>
-171	<p>Invalid expression</p> <p>The equation data element is invalid. (Refer to IEEE488.2,7.7.7.2.) For example, parentheses are not paired or a character violates the standard.</p>
112	<p>INVALID FILE NAME</p> <p>When the recall command (RECD <string>) or the re-save command (RESAVD <string>) was executed, a string that indicated a file name was not followed by a necessary extension and, as a result, the command was ignored. Add a required extension, and then perform recall or re-save. This message occurs, for example, when you attempt to execute the recall or re-save command without adding an extension (".STA", ".DAT", ".TXT") to a file name. Also, it does when you attempt to execute re-save of a graphics file without adding an extension (".TIF").</p>
-103	<p>Invalid separator</p> <p>The parser (syntax analysis program) expected a separator, but a character other than a separator was sent. For example, though the correct way is using ";" to separate 2 sent program messages like "MEAS IRIM;FMT LOGY", a semicolon (;) to separate the program messages is missing, like "MEAS IRIM FMT LOGY".</p>
-151	<p>Invalid string data</p> <p>Character string data was expected but given string data was invalid for some reasons. (Refer to IEEE488.2,7.7.5.2.) For example, the END message was received before the end quotation mark character appeared.</p>
-131	<p>Invalid suffix</p> <p>The suffix does not meet the syntax defined in IEEE488.2,7.7.3.2 or it is inappropriate for the 4294A.</p>

L

132 **LIST SWEEP ONLY**

When a sweep type other than the list sweep was specified, you attempted to execute a command to specify all segments (entire sweep range) as the search range setting (SEARNG FULL) or a command to specify a certain segment as the search target (SEGMNUM <value>) and, as a result, the command was ignored. Before setting the search range for the list sweep, specify the list sweep as the sweep type (command: SWPT LIST).

124 **LIST TABLE EMPTY OR INSUFFICIENT TABLE**

When the list sweep table was empty or insufficient, you attempted to select LIST as the sweep type (command: SWPT LIST) and, as a result, the command was ignored. Before selecting the list sweep as the sweep type, set the list sweep table correctly.

M

-250 **MASS STORAGE ERROR**

A mass storage error occurred.

A mass storage error other than -257 occurred.

88 **MATH FUNCTION NOT VALID FOR PERCENT FORMAT**

When the percent format was selected as the display format, you attempted to change the setting of data operations. In the percent format, data operations are fixed to delta % (command: MATH DELP), and therefore, you cannot change the data operation setting to DATA (command: MATH DATA), DATA-MEM (command: MATH DMNM), or DATA/MEM (command: MATH DDVM).

105 **MEASUREMENT PARAMETER NOT FOR ANALYSIS**

When a measurement parameter other than $|Z|$ -q was set, you attempted to execute a waveform analysis command (for example, OUTPCERR?) and, as a result, the command was ignored. Before executing a waveform analysis command, set the measurement parameter to $|Z|$ - θ (command: MEAS IMPH).

-258 **Media protected**

You attempted to save/delete data to/from the storage device or initialize the media, but the media was write-protected, and, as a result, the operation could not be executed. This message is displayed, for example, when you have specified the floppy disk drive as the storage device and a floppy disk is write-protected. If necessary, disable the write-protection for the floppy disk.

-311 **Memory error**

An error was detected in the memory of the 4294A.

34 **MEMORY TRACE NOT ACTIVE**

Though no data was stored in the memory trace, you attempted to execute a command (DISP MEMO, DMNM, and so on) that used the memory trace. The command was invalid. First, use the DATMEM command and store data in the memory trace.

94 **MEMORY TRACE NOT DISPLAYED**

	<p>When the memory trace was not displayed, you attempted to set the function that needed the display of the memory trace and, as a result, the command was ignored. For example, a command (MKRO MEMO or SCAF MEMO) corresponding to the MARKER ON [MEMORY] key display or the SCALE FOR [MEMO] key display was sent. Before setting the function that needs the display of the memory trace, display the memory trace (command: DISP MEMO or DISP DATM).</p>
-252	<p>Missing media</p> <p>You attempted to access the storage device, but media did not exit or was not installed correctly. This message is displayed, for example, when you specifies the floppy disk drive as the storage device but no floppy disk is set into the drive (correctly).</p>
-109	<p>Missing parameter</p> <p>The number of parameters is less than that the command requires. For example, though the "POIN" command requires 1 parameter like "POIN 101," no parameter is added like "POIN."</p>
36	<p>MUST BE MORE THAN 2 POINTS FOR ANALYSIS</p> <p>Though the calculation of equivalent circuit parameters (CALCULATE PARAMETERS key, CALC PARMS key, or CALECPARA command) was executed, because the number of points (NOP) within the sweep range (if the partial search function is on, within the specified search range) is 2, they cannot be calculated. Set the number of points within the sweep range (if the partial search function is on, within the specified search range) to 3 or more.</p>
N	
98	<p>NO ACTIVE MARKER</p> <p>When the marker was not displayed, you attempted to execute the marker moving (Marker?) function and, as a result, the command was ignored. For example, when the marker was not displayed, a command corresponding to the MKR?START key (MKRSTAR) was sent. Before executing the marker moving function, display the marker (command: MKR ON).</p>
0	<p>(No error)</p> <p>No error has occurred.</p> <p>This message is not displayed on the LCD. 0 is returned as the error number if no error has occurred in the instrument when the OUTPERRO? command is sent through GPIB.</p>
100	<p>NO FIXED DELTA MARKER</p> <p>When the fixed Δ marker (FIXED DMKR) was not displayed, you attempted to execute a command of a function that needed the display of the fixed Δ marker and, as a result, the command was ignored. For example, when the fixed Δ marker was not displayed, a command corresponding to the FIXED DMKR VALUE, FIXED DMKR AUX VALUEN key (DMKRVAL <value>, DMRRRAUV <value>) was sent. Before executing a function using the fixed Δ marker, first display the fixed Δ marker (command: DMKR FIX).</p>
113	<p>NO STATE/DATA FILES ON DISK</p> <p>Though you attempted to display the list of files and directories on a floppy disk on the softkey label by executing the recall ([Recall]) key, file re-save (RE-SAVE FILE) key, file deletion (PURGE FILE) key, directory change (CHANGE DIRECTORY) key, or file copy</p>

(COPY FILE) key, no file or directory corresponding to the execution of the key was on the floppy disk.

116 **NO STATE/DATA FILES ON MEMORY**

Though you attempted to display the list of files and directories on a volatile memory disk or nonvolatile memory disk (flash memory) on the softkey label by executing the recall ([Recall]) key, file re-save (RE-SAVE FILE) key, file deletion (PURGE FILE) key, directory change (CHANGE DIRECTORY) key, file copy (COPY FILE) key, and so on, no file or directory corresponding to the execution of the key was on the volatile memory disk or nonvolatile memory disk (flash memory).

55 **NOT ENOUGH DATA**

When data was sent from the controller to the 4294A in the FORM2, FORM3, or FORM5 data transfer format, the amount of the sent binary data was too small, or data items did not reach the number of points (NOP) set in the 4294A. Set data to be sent or the number of points of the 4294A correctly.

-120 **Numeric data error**

Numeric data (including numeric data without a decimal point) causes an error. A numeric value error other than -121 to -129 occurred.

-128 **Numeric data not allowed**

A numeric value data element (that did not violate the standard) was received at where the 4294A did not accept any numeric value data elements.

O

140 **OSC LEVEL MONITOR NOT VALID**

When the oscillator level monitor was not on, you attempted to execute a command to turn on the marker AC voltage level monitor or the marker AC current level monitor (MKRMON ACV or MKRMON ACI) and, as a result, the command was ignored. Before turning on the marker AC voltage level monitor or the marker AC current level monitor, turn on the AC bias level monitor (command: OMON ON).

P

-220 **Parameter error**

An error not included in error numbers between -221 and -229 occurred during the analysis of a program data element. This error occurs, for example, when you attempt to specify an invalid value for the LOAD correction reference value or the LOAD correction data (values that are not finite when converted to R-X form impedance values). If this error occurs, the command is ignored. This error also occurs when you attempt to specify an invalid LOAD correction reference value from front panel keys.

-108 **Parameter not allowed**

The number of parameters is larger than that the command requires. For example, though the "POIN" command requires 1 parameter like "POIN 101," 2 parameters are added like "POIN 101,1."

89 **PERCENT FORMAT NOT SELECTED**

	<p>When the percent format was not selected as the display format, you attempted to select delta % as the data operation setting (you sent the MATH DELP command). If you want to select delta % as the data operation setting, the percent format (command: FMT PERC) must have been selected as the display format.</p>
48	<p>PHASE LOCK LOOP UNLOCKED</p> <p>Anomalies in the 4294A's internal circuit were detected (phase lock loop was not locked). The instrument needs adjustment or repair. Contact your local Agilent Technologies sales office or the company you purchased this instrument from.</p>
193	<p>POWER ON TEST FAILED</p> <p>In the power-on self-test, a fault of the instrument was detected. Contact your local Agilent Technologies sales office or the company you purchased this instrument from.</p>
26	<p>PRINTER: not on, not connected, out of paper</p> <p>The printer does not respond to the control from the 4294A. Check the power to the printer, online status, paper, and so on. Or, the connected printer may not be supported. For information on supported printers, refer to the "Options and accessories" chapter.</p>
-284	<p>Program currently running</p> <p>The program is running.</p> <p>This message is displayed when you attempt to perform an operation that cannot be executed during the execution of a program. For example, when you attempt to delete a running program.</p>
-280	<p>Program error</p> <p>A program error.</p> <p>An error occurred in a downloaded program. An error other than -281 to -289 occurred.</p>
-112	<p>Program mnemonic too long</p> <p>The length of the header exceeds 12 characters. (Refer to IEEE488.2,7.6.1.4.1.))</p>
-286	<p>Program runtime error</p> <p>An error occurred while an HP Instrument BASIC program is being executed. To obtain detailed information on the occurred error, use the ERRM\$ or ERRM command of HP Instrument BASIC.</p>
-285	<p>Program syntax error</p> <p>A program syntax error.</p> <p>A program syntax error occurred in the downloaded program.</p>
Q	
-430	<p>Query DEADLOCKED</p> <p>Status that causes a "DEADLOCKED" Query error. (Refer to IEEE488.2,6.3.1.7.) This error occurs, for example, when both input and output buffers become full and the 4294A cannot continue processing.</p>
-400	<p>Query error</p> <p>A comprehensive Query error occurred for which 4294A could not detect further details of</p>

the error. This code simply indicates the occurrence of a Query error that is defined in IEEE488.2, 11.5.1.1.7 and 6.3.

-410

Query INTERRUPTED

Status that causes an “INTERRUPTED” Query error. (Refer to IEEE488.1, 6.3.2.3.) This error occurs, for example, when, after Query, data byte (DAB) or GET is received before the response has been sent completely.

-420

Query UNTERMINATED

Status that causes an “UNTERMINATED” Query error. (Refer to IEEE488.2, 6.3.2.) This error occurs, for example, when the 4294A is specified as a talker and an incomplete program message is received.

-440

Query UNTERMINATED after indefinite response

In a certain program message, after a Query that requested an ambiguous response was executed, another Query was received. (Refer to IEEE488.2, 6.5.7.5.7.)

-350

Queue overflow

The queue contains a certain code, instead of the code that caused this error. This code indicates that an error has occurred due to insufficient space in the queue but it has not been recorded.

R

111

RECALL ERROR: INSTR STATE PRESET

Because an error occurred during reading out a file, the 4294A is being preset. This error occurs, for example, when data in a file to be read out is destroyed or when an extension for a file name does not match with the contents of the file.

S

110

SAVE ERROR

When saving a file, anomalies in the storage media were detected. For example, if you attempt to save a file on a floppy disk, it may be damaged. Check to see if there is no problem in the storage media.

90

SCALE PARAMETER NOT VALID

You attempted to set a display scale not settable for the selected display format and, as a result, the command was ignored. For example, when the log scale (command: FMT LOGY) was selected as the display format, you attempted to perform the SCALE/DIV setting (command: SCAL <value>).

102

SEARCH RANGE TYPE IS NOT SEGMENT

Though, in the list sweep, all segments (entire sweep range) were specified as the search range (command: SEARNG FULL), you attempted to execute a command to specify a certain segment as a search target (SEGMNUM <value>) and, as a result, the command was ignored. Before executing the search function by specifying a certain list sweep segment, set the search range to a single segment (command: SEARNG SEGMENT).

101

SEARCH WIDTH OFF

	When the band width function was off, you attempted to execute a command to search the cutoff point on the trace (WIDSIN or WIDSOUT) and, as a result, the command was ignored. Before executing the cutoff point search of the band width function, turn on the band width function (command: WIDT ON).
-330	Self-test failed <p>The result of the self-test was a failure. Contact your local Agilent Technologies sales office or service center, or refer to the service manual.</p>
-221	Setting conflict <p>A program data element complying with the syntax standard was analyzed but the 4294A could not execute it at present.</p>
-150	String data error <p>An error not included in error numbers between -151 and -159 occurred during the syntax analysis of a string data element.</p>
-158	String data not allowed <p>A string data element was received at where the 4294A did not accept any string data elements.</p>
-130	Suffix error <p>A suffix error.</p> <p>An error other than -131 to -139 occurred in the notation of a suffix.</p>
-138	Suffix not allowed <p>A suffix is added to a numeric value element to which no suffix can be added.</p>
-134	Suffix too long <p>The suffix is too long.</p> <p>The suffix contains the notation of 12 characters or more. (Refer to IEEE488.2,7.7.3.4.)</p>
-102	Syntax error <p>There is a command or data type that cannot be recognized. For example, though the 4294A did not accept any strings, a string was received.</p>
-310	System error <p>One of “system errors” defined for the 4294A occurred.</p>

T

87	THETA MEASUREMENT NOT SELECTED <p>When the setting of the phase (q) was not active as a measurement parameter, you attempted to execute a command to set the phase unit (PHAU DEG or PHAU RAD) or a command to set the phase expansion display (EXPP ON or EXPP OFF) and, as a result, the command was ignored. The active status of the phase (θ) setting means:</p> <ul style="list-style-type: none"> • $Z -\theta$ or $Y -\theta$ is selected as a measurement parameter and trace B is active. • COMPLEX Z-Y is selected as a measurement parameter, and the display format is PLOAR (polar coordinates display format) for the selected active trace.
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Before executing a command to set the phase unit or a command to set the phase expansion display, perform one of the above settings.

-124

Too many digits

The number of digits of the mantissa of the decimal value data element exceeds 255 except preceding 0s. (Refer to IEEE488.27.7.2.4.1.)

64

TOO MANY SEGMENTS

You attempted to add segments whose quantity exceeded the maximum number (18) to the limit line table. The number of segments you can set in the limit line table is up to 18.

77

TOO MANY SEGMENTS OR POINTS

During the edit of the list sweep table, you attempted to set a value that exceeded the maximum of segments (18), the maximum number of points per segment (201), or the maximum number of total points in all segments (801). Set a value of the number of segments or the number of points that does not exceed the maximum value.

54

TOO MUCH DATA

When data was sent from the controller to the 4294A in the FORM2, FORM3, or FORM5 data transfer format, the amount of the sent binary data was too large, or data items exceeded the number of points (NOP) set in the 4294A. Set data to be sent or the number of points of the 4294A correctly.

-223

Too much data

The received block, equation, or string type program data complied with the standard but its amount exceeded the limit that the 4294A could deal with, due to memory or device-specific conditions related to memory.

-210

Trigger error

A trigger error. An error other than -211 to -219 occurred.

-211

Trigger ignored

A trigger command or trigger signal was received and recognized by the 4294A, but it was ignored due to the timing relationship with the 4294A (for example, when the 4294A was not ready to respond).

U

-113

Undefined header

A header not defined for the 4294A was received. For example, “*XYZ” not defined for the 4294A was received.

19

UNEXPECTED DATA DETECTED

During the measurement of calibration data (OPEN, SHORT, LOAD) for user calibration, fixture compensation, and four-terminal pair extension setting, abnormal data was detected and the acquisition of the calibration data was aborted. Check to see if there is no problem in standards or setup you use.

W

142

WRONG I/O PORT DIRECTION

For a 24-bit input/output (I/O) shared port (port C and port D), you attempted to execute input/output (I/O) of data in the direction opposite from the preset input/output direction. The command was invalid. For example, if you use the CIN command to specify port C as an input port and then use the OUTCIO <value> command to output data from port C, this error is displayed.

Error messages
Order of Alphabet